CANMET

BUSINESS PLAN 1991-1994

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CANMET BUSINESS PLAN 1991-1994

The Canada Centre for Mineral and Energy Technology

Energy, Mines and Resources Canada
Énergie, Mines et Ressources Canada

EXECUTIVE SUMMARY

The Canada Centre for Mineral and Energy Technology (CANMET) is continuing to enhance its role as Canada's major technology centre for the minerals, metals and energy industries. CANMET is helping these industries to enhance their competitiveness, improve health and safety, and protect the environment.

CANMET, in partnership with industry, will continue to conduct and sponsor predominantly commercial and cost-shared research and development, as well as technology transfer. As CANMET adapts to an expanding environmental mandate, its goals are continuously being tuned to reflect the following objectives:

- enhancing the competitiveness of the Canadian minerals, metals and energy industries;
- contributing to higher standards of health, safety and environmental quality;
- helping to attain efficient and sustainable production and use of Canada's energy and mineral resources;
- encouraging industry to fund more R&D; and
- supporting government policy initiatives.

CANMET's major area of expertise is long-term Strategic Research and Development (45 percent). This research is designed to meet Canada's future technological needs in the minerals, metals and energy sectors. Incremental Research and Development, the next largest field of CANMET research (35 percent), builds on existing technologies and knowledge, responding to industry's more immediate, short-term needs.

Mandated and specialized services, which are normally fully recovered from the client, make up 10 percent of CANMET's research effort, while the remaining 10 percent is reserved for exploratory research.

CANMET's Clients and Partners

CANMET's clients and partners include both industry and public sector organizations. Industrial clients and partners include the companies and organizations involved in the recovery, processing, transportation and use of Canada's minerals, metals and energy commodities, as well as industry associations. Public sector clients and partners include Energy Mines and Resources Canada (EMR), other federal departments and agencies, the provinces, crown corporations, electrical utilities, granting agencies and universities. CANMET maintains close relationships with other research organizations, both nationally and internationally, often signing Memoranda of Understanding.

Marketing Strategy

CANMET's marketing strategy includes:

- a market-oriented analysis of CANMET's R&D products and services;
- an international strategy;
- policies on intellectual property;
- communications and promotional activities; and
- face-to-face marketing.

Challenges and Opportunities in the 1990s

Several factors will have an impact on CANMET's strategic direction, offering numerous challenges and opportunities. Among the more significant are:

- the unprecedented impact of environmental considerations on government and industry decision-making;
- the ongoing need to ensure public and occupational health and safety;
- the necessity for maintaining a wide range of energy options and strengthening diversification and energy efficiency in Canada, the most energy-intensive industrialized economy in the world;
- the need to dedicate considerable resources toward improving mining and processing technologies to aid a mining industry that has suffered several years of low commodities prices and overly abundant supply; and
- the administrative environment, including the changing role of the public service.

CANMET, while maintaining its thrust to meet client needs, is responding to these challenges by focussing on the following areas.

- CANMET is striving to face the environmental challenge by creating a technological response to carbon dioxide emissions from carbon-based fuels, that is developing ways to use these fuels more efficiently and cleanly while developing alternative fuels. CANMET is also working to improve technologies that will reduce contamination of our air, water and soil.
- CANMET is continuing to look for ways of improving the health and safety of workers in client industries.
- CANMET is responding to the energy challenge by developing technologies that will support increased development of the oil sands, effectively exploit renewable energies, and improve energy efficiency.

- CANMET is dedicating a significant part of its efforts to improving mining and processing technologies that will help extend the economic life of existing ore bodies and help maintain minerals and metals markets.

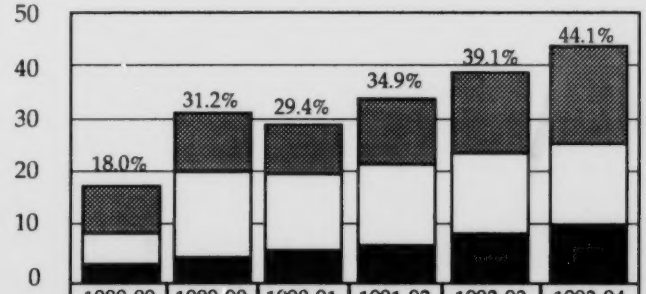
- CANMET will also follow a number of strategic directions in response to the restructuring of the public service. CANMET is adapting by striving for greater administrative and financial flexibility so as to improve its performance in research and development, technology transfer, marketing, information services and project management.

Performance Monitoring and Financial Resources

CANMET's performance is assessed by audit and evaluation, and is measured in some critical areas by a set of key performance indicators (KPIs). The KPIs measure how well CANMET is working with industry, levering its funds and attracting cost-recovery revenue. The following table indicates the evolution of the KPIs that measure client contributions to CANMET programs in proportion to total CANMET expenditures.

With the addition of the Efficiency and Alternative Energy Technology Branch, CANMET's total budget has increased from $75.4 million in 1988-89 to a projected $119 million for 1993-94. Within the planning period, the total leveraging will increase from 18 percent to 44.1 percent of total CANMET resources.

Client Contributions: Percentage of Total CANMET Expenditures



	1988-89	1989-90	1990-91	1991-92	1992-93	1993-94
Task-shared Work	9.3	9.7	9.1	12.3	14.9	18.7
Cost-shared Work	5.9	17.2	14.6	15.8	15.6	15.3
Cost-recovery	2.8	4.3	5.7	6.8	8.6	10.1
Total Budget ($ million)	75.4	110.2	109.8	117.2	116.7	119.0

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TABLE OF CONTENTS

INTRODUCTION 1

PART A

CHAPTER 1
MISSION AND STRUCUTRE 5
Mandate 5
Structure of the R&D Program 6
Figure 1.1: Schematic Relationship Among CANMET's Categories of R&D 6
Organizational Structure 7
Figure 1.2: CANMET Organizational Chart 8
..... 9

CHAPTER 2
CORPORATE MARKETING STRATEGY 11
Clients and Partners 11
Marketing Strategy 12
CANMET's Role in Canada's Research and Development 12
..... 14

CHAPTER 3
CHALLENGES AND OPPORTUNITIES 15
The Environmental Challenges 15
Health and Safety 16
The Energy Challenges 20
Figure 3.1: Canadian Oil Supply Forecast 20
Figure 3.2: Canada's Total Electrical Generating Capacity 21
The Minerals and Metals Challenges 22
Economy and Economic Policy Challenges 24
Figure 3.3: Canada's Medium-term Economic Forecasts 25
R&D Spending Intentions of Clients 26
Figure 3.4: R&D Spending Intentions of Companies in Primary Sector and Other Sectors 27
Changes in the Public Service 27
..... 28

CHAPTER 4
RESEARCH AND DEVELOPMENT THRUSTS FOR CANMET 29
Energy Production 29
Energy Systems 30
Energy End-use 31
Minerals and Metals Production 31
Minerals and Metals End-use 32
Strategic Technologies 33
..... 33

CHAPTER 5
MANAGERIAL AND ADMINISTRATIVE INITIATIVES 35
Human Resource Issues 35
Linkages and Relationships 36
General Processes and Systems 36
Geographical Considerations 37
..... 38

Structural Changes in the Public Service 38
Changes to CANMET's Institutional Framework 40

CHAPTER 6
RESOURCES 41
Financial Resources 42
Human Resources 42
Table 6.1: Estimated Resource Allocations by Sources of Funds 43
Table 6.2: Estimated Resource Allocations by Branch and Expenditure Category 44
Capital Resources 45
Table 6.3: Person-year Allocations by Branch 45

CHAPTER 7
PERFORMANCE MONITORING 47
Reviews 48
Key Performance Indicators 48
Table 7.1: Cost-recovery Targets 48
Table 7.2: Client Contributions to Task-shared Agreements 50
Table 7.3: Client's Share of Cost-shared Agreements as a Percentage of Total Costs 50
Table 7.4: Secondments to and from CANMET 51
Audits and Evaluations 52
Table 7.5: Benefit/Cost Results of Selected CANMET Projects 53
Table 7.6: Client Contributions in Relation to CANMET Resources 54
Table 7.7: Client Contributions: Percentage of Total CANMET Expenditures 54

PART B

CHAPTER 8
EFFICIENCY AND ALTERNATIVE ENERGY TECHNOLOGY BRANCH 55
Mission 56
Objectives 56
Strategies 56
Activities 57
Branch Organization 58
ALTERNATIVE ENERGY DIVISION 59
Mission 59
Objectives 59
Structure of the R&D Program 59
Organizational Structure 60
Marketing Strategy 60
Strategic Thrusts, Plans and Outputs 62
Resources 68
Table 8.1: Resource Allocations of the Alternative Energy Division by Category of Expenditures 68
Performance Monitoring 68

ENERGY DIVERSIFICATION RESEARCH LABORATORY 69
Mission and Objectives 69
Organizational Structure 70
Marketing Strategy 70
Strategic Thrusts, Plans and Outputs 71
Administration and Information Transfer 75
Resources 76
Table 8.2: Resource Allocations for the Energy Diversification Research Laboratory by Category of Expenditure 76
ENERGY EFFICIENCY DIVISION 77
Mission 77
Objectives 77
Structure of the R&D Program 77
Marketing Strategy 77
Strategic Thrusts, Plans and Outputs 79
Management and Administration Issues 83
Resources 84
Table 8.3: Estimated Resource Allocations of the Energy Efficiency Division 84
Table 8.4: Resource Distribution by Program 85
Performance Monitoring 85
Table 8.5: Key Performance Indicators of the Energy Efficiency Division 85
BUSINESS AND TECHNOLOGY COORDINATION DIVISION 86
Mission 86
Objectives 86
Organization 86
Marketing Strategy 86
Strategic Thrusts, Plans and Outputs 87
Resources 90
Table 8.6: Resource Allocations of the Business and Technology Coordination Division by Category of Expenditure 90
Performance Monitoring 90
Table 8.7: Key Performance Indicators of the Business and Technology Coordination Division 90

CHAPTER 9
FOSSIL FUELS TECHNOLOGY BRANCH 91
Organization 92
COAL RESEARCH LABORATORIES 93
Mission 93
Objectives 93
Structure of the R&D Program 94
Table 9.1: The Coal Research Laboratories' R&D Program 94
Table 9.2: The Coal Research Laboratories' R&D Program by Type of Research 95
Structure of the Division 95
Marketing 96
Strategic Thrusts, Plans and Outputs 99
Resources 101

Table 9.3: Resource Allocations of the Coal Research Laboratories by Category of Expenditure 101
Table 9.4: The Coal Research Laboratories' Research Distribution by Program 102
Performance Monitoring 103
Table 9.5: Key Performance Indicators of the Coal Research Laboratories 103
ENERGY RESEARCH LABORATORIES 104
Mission 104
Objectives 104
Structure of the R&D Program 104
Organization 105
Market Strategy 105
Strategic Thrusts, Plans and Outputs 107
Resources 117
Table 9.6: Resource Allocations of the Energy Research Laboratories by Category of Expenditure 117
Table 9.7: Energy Research Laboratories' Research Distribution by Program 118
Table 9.8: Energy Research Laboratories' Person-year Resources by Program 119
Performance Monitoring 120
Table 9.9: Key Performance Indicators of the Energy Research Laboratories 120

CHAPTER 10
MINERAL TECHNOLOGY BRANCH 121
Organization 122
METALS TECHNOLOGY LABORATORIES 123
Mission and Objectives 123
Structure of the R&D Program 123
Table 10.1: The Metals Technology Laboratories' R&D Program 124
Table 10.2: The Metals Technology Laboratories' R&D Program by Technology 125
Organization and Structure 125
Marketing Strategy 125
Strategic Thrusts, Plans and Outputs 129
Resources 134
Table 10.3: Resource Allocations of the Metals Technology Laboratories by Category of Expenditure 134
Table 10.4: Metals Technology Laboratories' Research Distribution by Program 135
Performance Monitoring 136
Table 10.5: Key Performance Indicators of the Metals Technology Laboratory 136
MINERAL SCIENCES LABORATORIES 137
Mission 137
Objectives 137
Structure of the R&D Program 137
Figure 10.1: Mineral Science Laboratories' R&D Distribution by Category 138
Organizational Structure 138
Marketing Strategy 139
Strategic Thrusts, Plans and Outputs 141
Resources 149
Table 10.6: Resource Allocation of the Mineral Sciences Laboratories by Category of Expenditure 150
Table 10.7: Mineral Sciences Laboratories' Research Distribution by Program 150

Performance Monitoring 151
Table 10.8: Key Performance Indicators of the Mineral Sciences Laboratories 151
MINING RESEARCH LABORATORIES 152
Mission 152
Objectives 152
Structure of the R&D Program 152
Table 10.9: Mineral and Energy Technology Sector Activities 153
Table 10.10: Activities by Mandated Category and Type of R&D 153
Marketing Strategy 154
Strategic Thrusts, Plans and Outputs 155
Resources 157
Table 10.11: Mining Research Laboratories' Research Distribution by Program 163
Table 10.12: Mining Research Laboratories' Resource Allocations by Category of Expenditure 164
Table 10.13: Breakdown of the Mining Research Laboratories' Person-year Resources 165
Performance Monitoring 165
Table 10.14: Key Performance Indicators of the Mining Research Laboratories 166

CHAPTER 11
POLICY, PLANNING AND SERVICES BRANCH 167
Mission 167
Branch Organization 168
ADMINISTRATIVE SERVICES DIVISION 168
Mission 170
Objectives 170
Marketing Strategy 170
Strategic Thrusts, Plans and Outputs 170
Resources 170
Table 11.1: Resource Allocations of the Administrative Services Division by Category of Expenditure 171
ENGINEERING AND TECHNICAL SERVICES DIVISION 171
Mission 172
Organizational Structure to Section Level 172
Marketing Strategy 172
Strategic Thrusts, Plans and Outputs 172
Resources 173
Table 11.2: Resource Allocations of the Engineering and Technical Services Division by Category of Expenditure 174
Performance Monitoring 174
Table 11.3: Key Performance Indicators of the Engineering and Technical Services Division 174
EXPLOSIVES DIVISION 175
Mission 176
Marketing Strategy 176
Strategic Thrusts, Plans and Outputs 176
Resources 176
Table 11.4: Resource Allocations of the Explosives Division by Category of Expenditure 176
177
177

Performance Monitoring 178
Table 11.5: Inspection Activities of the Explosives Division 178
LIBRARY AND DOCUMENTATION SERVICES DIVISION 179
Mission 179
Objectives 179
Marketing Strategy 179
Strategic Thrusts, Plans and Outputs 180
Resources 182
Table 11.6: Resouce Allocations of the Library and Documentation Services Division by Category of Expenditure 182
Performance Monitoring 183
Table 11.7: Key Performance Indicators of the Library and Documentation Services Division 183
RESEARCH PROGRAM OFFICE 184
Mission 184
Objectives 184
Organizational Structure 184
Client Relations 184
Strategic Thrusts, Plans and Outputs 185
Resources 187
Table 11.8: Estimated Resource Allocations of the Research Program Office by Category of Expenditure 187
Performance Monitoring 187
TECHNOLOGY MARKETING DIVISION 188
Mission 188
Objectives 188
Organizational Structure 188
Clients 189
Strategic Thrusts, Plans and Outputs 190
Resources 192
Table 11.9: Resource Allocations of the Technology Marketing Division by Category of Expenditure 192
Performance Monitoring 192
Table 11.10: Key Performance Indicators of the Technology Marketing Division 192

INTRODUCTION

Purpose and Structure of the Plan

The annual business plan of the Canada Centre for Mineral and Energy Technology (CANMET) has two principal functions. First, it describes CANMET's strategic objectives for the three years covered by the plan, and how they will be met. Second, it fulfils CANMET's obligation as a government technology centre to submit an annual business plan to the Minister of Industry, Science and Technology. The federal government's Technology Centres Policy is intended to make the operations of participating government laboratories more commercially oriented, and more relevant to the clients served by the laboratories, particularly those from industry.

This business plan is in two parts: Part A describes CANMET's mission and structure, corporate marketing strategy, challenges and opportunities, strategic directions for the planning period, resources, and measures established to monitor performance. Part B provides the detailed business plans and outputs of CANMET's four branches.

Policy Framework

CANMET develops its plans and programs while taking into consideration policy direction and advice from such groups as the Minister's National Advisory Council to CANMET (MNACC or the Council), the Panel on Energy Research and Development (PERD), and the Policy Sectors of the Department of Energy, Mines and Resources (EMR). CANMET also considers the overall science and technology policy of the Government.

Advice from MNACC

As a government technology centre, CANMET has an industry-led advisory board, MNACC. The Council and its supporting committees review CANMET's technical programs annually, and make recommendations to the Minister of Energy, Mines and Resources on the future direction of these programs, and on the broad level of resources that should be allocated.

In its 1989 report, the Council noted that CANMET continues to make good progress towards its business development goals, and that industry contributions continue to increase. The Council endorsed CANMET's Intellectual Property Policy, but noted that restrictions on ownership of intellectual property deter industry participation with CANMET. The Council recommended that CANMET's expertise in fossil fuel combustion be made available to developing countries, and recognized the value of this expertise in reducing global carbon dioxide (CO_2) emissions.

The Council's technical committees recommend that CANMET should:

- allocate more resources to coal utilization, as opposed to coal production, as one way of reducing CO_2 emissions;
- emphasize environmental awareness in all aspects of its research programs in metals and materials;

- expand its work on the alkali reactivity of concrete, which is considered to be a problem of national importance;
- maintain and enhance its proactive stance in identifying mining-industry research needs; and
- keep government policymakers and industry informed of environmental research results in the oil and gas area.

Federal Program on Energy R&D

The interdepartmental Panel on Energy Research and Development coordinates the distribution of funds from the Federal Program on Energy Research and Development to the 12 managing federal departments and agencies. PERD aims to develop the science and technology base for a diversified, environmentally sustainable energy economy. In 1988-89, the Government confirmed PERD's new three-year plan, allotting it $90 million a year. This allotment is augmented by contributions from the private sector and participating departments. More than half of the federal funds are directed to research in two important areas: the environment and health and safety. More than 60 percent of the program's budget is spent in the private sector.

CANMET, as the major energy research centre of the federal government, manages almost $50 million (133 person-years) of PERD funds annually for research and development projects. CANMET specifies deliverables under programs with the principal objectives of:

- promoting the continuing development of a Canadian technology base for the efficient use of energy in all sectors of the economy;
- providing scientific and technical advances that contribute to the safe, efficient and environmentally acceptable exploitation and use of Canadian coals;
- encouraging the development of science and technology to exploit biomass, solar, wind and other renewable energy resources, and investigating broad-scale environmental issues associated with energy developments;
- establishing the technical and regulatory base for a transition to alternative transportation fuels in the next century, through the use of coal, bitumen, heavy oils, natural gas, biomass and electricity;
- improving materials technologies for offshore hydrocarbon exploration and production systems, pipelines and their regulation;
- monitoring Canada's ability to collaborate in the R&D programs of the International Energy Agency; and

- establishing a new energy research laboratory at Varennes, Québec, to cost-share R&D relating to energy efficiency, energy-environment and diversity of energy supplies.

The PERD Program is being evaluated in 1990-91, by an external consulting firm, in terms of its rationale, structure, objectives, benefits and delivery mechanisms. CANMET anticipates changes in priorities, in response to the evaluation and to the Government's environmental agenda.

Minerals and Metals Policy

Canada's minerals and metals policy contains six objectives to promote the exploration, development, production and utilization of the nation's mineral and metal wealth. The policy is designed to:

1. provide a fair and balanced fiscal and regulatory framework;
2. foster the development of the minerals and metals sector, as a foundation for regional economic development;
3. promote improved technological performance and increased international competitiveness in all facets of the industry;
4. assist companies affected by industrial adjustment;
5. increase mineral and metal exports and improve access to new and traditional markets; and
6. provide timely and accurate economic, technological and scientific information to industry, the federal and provincial governments, labour and the public.

The third and sixth objectives are most relevant to CANMET's mandate. As a result, CANMET focuses its efforts in two strategic areas: (1) research to assist industry, and (2) health, safety and environmental research.

There is little reason to expect significant changes in the federal government's basic approach to its minerals and metals policy in the early 1990s. The most noteworthy change will be the greater importance accorded to protection of the environment.

Energy Policy

Canada's energy policy includes the following six goals:

1. economic growth through the establishment of a policy that enables private investment decisions to be made that promote increased investment and employment;
2. flexibility and diversity of Canada's energy economy by opening markets and increasing choices for producers and consumers;

3. security of supply through development and efficient use of energy resources, and through emergency planning;

4. national reconciliation through energy agreements with provincial governments;

5. opportunity for Canadians to participate in the domestic petroleum industry through measures that encourage private investment on a non-discriminatory basis; and

6. environmental responsibility through measures to protect and improve our environment for future generations.

CANMET's research and development mandate is directly relevant to the three goals that deal with security of supply, flexibility and diversity of the economy, and environmental protection.

The most important change in the Government's approach to energy in the 1991-94 planning period will be the greater priority that it gives to environmental factors when formulating energy policies and programs. Other issues affecting the Government's approach include instability in the Middle East, the future role of nuclear energy, megaprojects, northern development, interprovincial and international trade, and the increasing importance of energy efficiency and diversity.

Science and Technology Policy

Canada's science and technology policy explicitly recognizes the importance of science and technology in building Canada's future, and in promoting economic, regional and social development. The policy recognizes the need to increase industrial R&D, help small- and medium-sized technology-based companies, and improve technology transfer in Canada through its "Innovaction Program." The policy also recognizes the importance of strategic technologies to Canadian industry, and how we must capitalize on R&D from other countries.

To achieve the objectives of this national policy, the federal government funds R&D that is performed by the private sector, as long as this is compatible with departmental missions. The Government also uses federal R&D allocations to lever contributions by industry and provincial governments to increase the overall level of R&D in Canada.

PART A

1 MISSION AND STRUCTURE

Mandate

CANMET has moved far in its philosophy and culture since becoming, in 1987, a designated technology centre. We are clearly more attuned to industry's needs, and we are getting increasing leverage on its research funds. It is probable that CANMET, for the foreseeable future, will remain on the path it is now forging.

CANMET, in partnership with industry, will continue to perform and sponsor predominantly commercial and cost-shared R&D, and technology transfer. The principal objectives will change to some extent, reflecting CANMET's increased scope and mandate, and the increased importance of the environment. Our mandate will be to:

- enhance the competitiveness of the Canadian minerals, metals and energy industries;
- help improve health, safety and environmental quality;
- help attain efficient and sustainable production and use of Canada's energy and mineral resources;
- support government policy initiatives; and
- increase industry expenditures on R&D.

Structure of the R&D Program

CANMET's R&D program is divided into four broad categories.

Strategic Research and Development covers research, development and pilot demonstration projects that establish and sustain CANMET's technology base. Projects in this group tend to be long-term and large, and, because of the associated risk, merit the leadership role being taken by CANMET, in association with industry. This category accounts for about 45 percent of CANMET's research budget and is increasingly cost-shared with industry.

Incremental Research and Development consists of projects that extend and improve existing technologies and knowledge. The work responds to the more short-term needs of industry, and is often done in conjunction with a single client under a cost-recovery or joint-work agreement. Work in this category represents about 35 percent of CANMET's research budget.

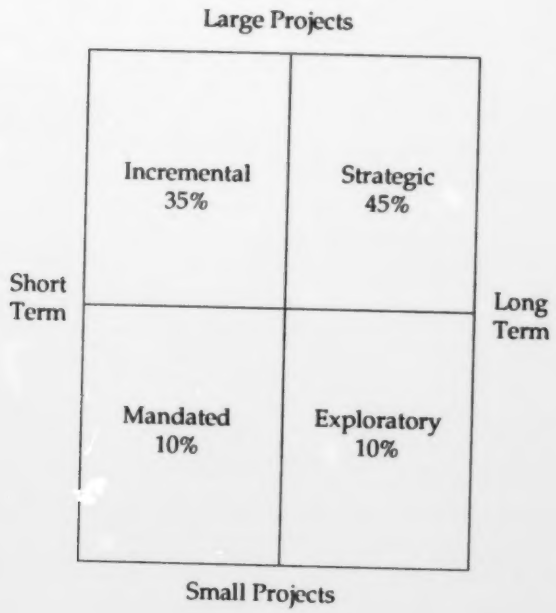
Mandated and Specialized Services are routine procedures performed either because CANMET has unique facilities or expertise, or because CANMET has a legal obligation to conduct the work. An example of these services is explosives testing in support of the federal government's administration of the *Explosives Act and Regulations*. The cost of work in this category, which represents about 10 percent of CANMET's research budget, is normally fully recovered from the client.

Exploratory Research consists of basic research that is relevant to CANMET's mission, government priorities, and the long-term needs of

industry. However, it may not be directly supported by an outside client. This category accounts for about 10 percent of CANMET's research budget.

Figure 1.1 shows the schematic relationship between these categories.

Figure 1.1
Schematic Relationship Among CANMET's Categories of R&D



CANMET also groups its programs into three areas: productivity, or support to industry; protection, or enhancement of health, safety and the environment; and policy, or advice to government.

Virtually all of CANMET's projects have some relevance to the environment. This relevance will be strengthened, where appropriate. CANMET's share of projects dedicated to protection will increase during 1991-94 from the present 30 percent to 40 percent of R&D effort. Policy work will increase from 10 percent to 15 percent to reflect

increased involvement in developing environmental guidelines, standards and regulations. The balance of 45 percent will go to productivity-related work. It is important to bear in mind, however, that R&D on protection often has positive effects on productivity, and vice versa. These targets are averages for CANMET; they may vary from division to division, depending on the specific nature of the R&D work of each group.

Organization Structure

To plan and deliver its R&D program, CANMET is organized into four branches:

In mid-1989, CANMET took over responsibility for EMR's technology development efforts in the areas of energy efficiency and diversity. These activities are carried out by the Efficiency and Alternative Energy Technology Branch. This Branch includes the Alternative Energy Division, the Energy Efficiency Division, the Business and Technology Coordination Division and the Energy Diversification Research Laboratory in Varennes, Québec.

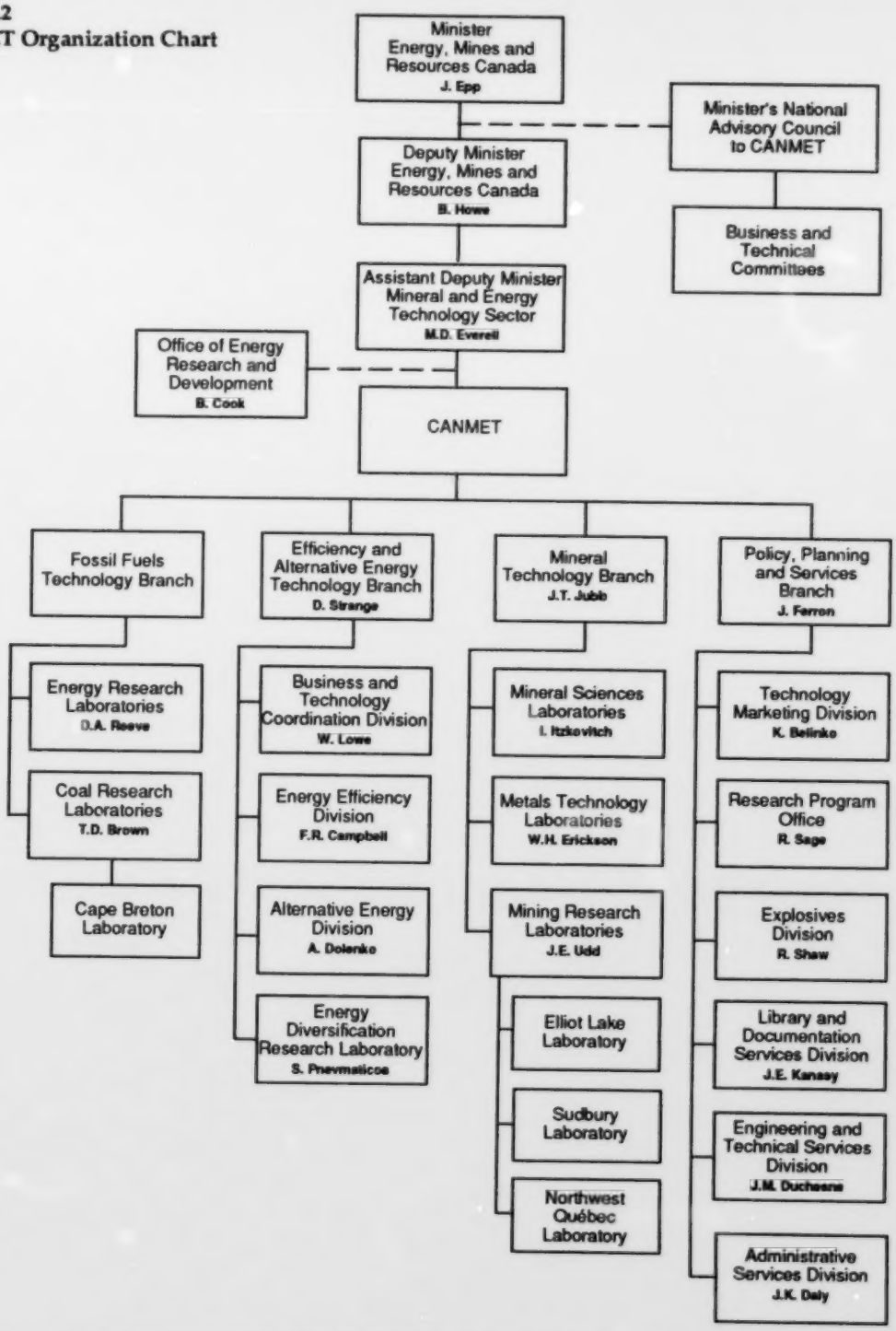
The Fossil Fuels Technology Branch consists of the Energy Research Laboratories and the Coal Research Laboratories.

The Mineral Technology Branch consists of the Mining Research Laboratories, the Mineral Sciences Laboratories and the Metals Technology Laboratories.

The Policy, Planning and Services Branch provides administrative, planning, marketing, information and technical support to the other branches, and is responsible for the administration of Canada's *Explosives Act and Regulations*.

CANMET's organization is shown in Figure 1.2.

Figure 1.2
CANMET Organization Chart



2 CORPORATE MARKETING STRATEGY

Clients and Partners

CANMET's clients are industry and the public sector. Industry includes the companies and organizations involved in the recovery, processing, transportation and use of Canada's minerals, metals and energy commodities; it also includes industrial associations. The public sector includes Energy, Mines and Resources, other federal departments and agencies, provinces, crown corporations, electrical utilities, granting agencies and universities. CANMET also responds to standards-writing organizations, environmental groups, and the public.

In serving these clients, CANMET ensures that it does not duplicate facilities and expertise available elsewhere in Canada. It does not undertake routine work, unless the required equipment and knowledge are unavailable elsewhere, or the work is a legislated responsibility. CANMET thus emphasizes research and development that draws on its extensive laboratory and pilot plant facilities, and on the wide experience of its researchers and technical support staff.

CANMET maintains close relationships with other research organizations. For example, it has signed Memoranda of Understanding with a number of organizations such as the National Research Council of Canada, and ORTECH International. It undertakes joint projects with numerous provincial research organizations and with government-industry consortia, such as the Alberta Oil Sands Technology and Research Authority. It collaborates with other countries through the International Energy Agency, and through Memoranda of Understanding with foreign research agencies.

Marketing Strategy

CANMET's corporate marketing strategy consolidates all major initiatives being undertaken in response to Treasury Board's Technology Centres Policy. The strategy includes:

- a market-oriented analysis of CANMET's R&D products and services;
- an international strategy;
- CANMET's intellectual property policies;
- communications and promotional activities; and
- face-to-face marketing.

Market-oriented Analysis of CANMET's R&D Products and Services

CANMET will prepare Business Opportunity Documents (BODs) to assess the marketability of new technologies and the commercial application of new products and services. BODs, which will be available to interested parties in the industrial-investment and research community, will form the basis of an inventory system for accumulating and tracking a number of technology transfer opportunities simultaneously. This system will become the foundation of CANMET's Catalogue of Technologies, which will be distributed in a number of ways, both domestic and international.

These Business Opportunity Documents will enable CANMET scientists to periodically review current marketing approaches to

specific technologies, and, as a result, further identify the markets for CANMET's products, services and processes.

International Strategy

To be competitive, CANMET must acquire technology from, and transfer technology to the international arena. Since CANMET is recognized worldwide for a number of world-class technologies (often developed in cooperation with Canadian industry), its international strategy focuses on enhancing this important flow of knowledge, facilitating technology inflow that will directly benefit Canadian industry, and acting as a technology gatekeeper. In addition, the strategy includes the establishment and maintenance of cooperative agreements with other countries by CANMET and its client industries. It also includes participation by CANMET scientists in international forums in areas related directly to CANMET's client-oriented R&D program.

Intellectual Property

CANMET has developed intellectual property policies, guidelines and procedures to facilitate the transfer and commercialization of intellectual property developed by CANMET, and to maintain a pool of know-how that Canadian companies can use. The policies have been instrumental in negotiating agreements with clients to achieve CANMET's policy objectives of cost-recovery, cost-sharing and joint R&D projects, and of ensuring that the benefits derived from exploitation of CANMET-developed intellectual property remain in Canada.

Communications

Effective communication is the essence of successful marketing. CANMET has undertaken a number of promotional activities in this area, including a newsletter entitled *Technology Focus* and an annual report that focuses on new technology transfer initiatives. The Centre has also organized regional seminars and conferences. Advertising, participation at trade shows, publishing of special interest topics (for example, CANMET's work on the environment), and development of mineral and energy technology databases are also part of CANMET's marketing strategy.

CANMET is developing a three-year communications plan with the assistance of EMR's Communications Branch. As part of this plan, CANMET will focus on promoting science and technology, placing emphasis on mineral, metal and energy technologies that are being developed in an environmentally sound manner. CANMET will target not only client industries but also the public, paying particular attention to Canada's youth. CANMET has a vested interest in attracting youth to its activities since it is currently faced with an aging scientific population.

Face-to-Face Marketing

Another important aspect of CANMET's marketing strategy is face-to-face marketing, which is essential in developing a rapport that leads to business development opportunities. Personal contact with current and potential clients is done through meetings, seminars, demonstrations, workshops and conferences. These opportunities allow CANMET staff to present and promote the capabilities and facilities of individual laboratories and of CANMET as a whole.

CANMET's Role in Canada's Research and Development

CANMET is the largest organization in Canada devoted to R&D in mineral, metal and energy technologies. Its 15 operating and support divisions, with laboratories and offices from Vancouver to Cape Breton, constitute a major R&D capability that serves both the public and private sectors.

CANMET's mandate is to support the efficient and sustainable development of Canada's mineral and energy resources, to enhance industrial competitiveness, health and safety and protection of the environment, and to support the federal government's policies.

CANMET's programs emphasize close collaboration with its clients in planning, funding and delivering R&D programs that are of benefit to Canada. These programs are based on exploratory research to develop new ideas and concepts for technologies; strategic R&D and pilot operations to bring new technologies closer to actual viability; incremental R&D to enhance existing technologies; direct services to clients, based on special expertise or equipment; and the provision of tests, evaluations and standards. About 80 percent of CANMET's effort is devoted to strategic and incremental R&D.

CANMET also supports university research, both directly and, in areas of mutual interest, in cooperation with the Natural Sciences and Engineering Research Council.

CANMET uses its resources to encourage the private sector to spend more on R&D in the private sector. To do this, CANMET seeks to lever funds through sharing R&D tasks, and through contracted R&D with partners from industry and other R&D organizations.

In general, CANMET's contribution to such R&D is in proportion to the level of risk involved, as well as to the extent that the work fits the needs of the Government and the client sectors.

In addition to levering outside funds, CANMET, in accordance with government policy, earns revenue from work done directly for its clients. Such revenues come from fees for certification of equipment or personnel, and from specialized testing and evaluation. As well, CANMET is seeking to increase earnings from its R&D, especially in the areas of strategic and incremental R&D, and where it has special expertise and facilities unique in Canada. However, CANMET's policy is not to compete directly with companies in the private sector whose business is performing R&D, consulting or testing.

Examples of CANMET's programs include:

- helping new industries develop and demonstrate technologies for alternative fuels and energy efficiency;
- addressing the environmental impacts of fossil fuel use (through cleaner coal combustion and upgrading of heavy oils and bitumens, for example);
- applying strategic technologies such as biotechnology, expert systems and advanced materials to improve productivity in the mineral and energy sectors; and
- investigating new mining and ground-control techniques for safe and efficient mining in deep mines and low-grade ore bodies.

3 CHALLENGES AND OPPORTUNITIES

CANMET's work is affected by many challenges. Among the more significant of these are:

- the environment;
- health and safety in the production and use of minerals, metals and energy;
- technical and economic challenges in the minerals, metals and energy sectors;
- the economy and associated government economic policies;
- R&D spending intentions of clients; and
- public-service revitalization efforts.

These challenges are described in this section, together with a summary of how CANMET proposes to respond to them. More detail on these responses is described in Chapter 4.

The Environmental Challenges

Environmental considerations are having an unprecedented impact on government and industry decision-making.

Government responses to environmental issues have taken several forms. At the international level, Canada has participated in important initiatives: it has proposed targets for carbon dioxide emissions, set controls on emissions of sulphur dioxide and oxides of nitrogen, and established an action plan for phasing out CFCs. Several major international conferences on the environment are scheduled to take place during the next three years. One measure of the Government's commitment to environmental action will be Canada's continued prominence among the countries promoting the adoption of international agreements on global environmental issues.

Sustainable Development

In March 1990, the Government released *The Green Plan, A Framework for Discussion on the Environment*. The Plan states that the Government's goal is:

". . . to make Canada, by the year 2000, the industrial world's most environmentally friendly country."

The Green Plan promotes the idea of sustainable development, which holds that the world must pursue: *"development which meets the needs of the present generation without compromising the ability of future generations to meet their own needs."*

Environmental Action: *The Green Plan*

CANMET will play a major role in the implementation and success of the Government's environmental action plan, *The Green Plan*. This will require CANMET to accelerate a number of its energy efficiency and other environmentally beneficial research programs.

Environment Canada released *The Green Plan* in December 1990. The Plan's primary goal is to secure, for current and future generations, a safe and healthy environment and a sound and prosperous economy. EMR, which is responsible for the orderly development of Canada's resources and the related science and technology, has an obligation to consider the environmental consequences of energy and mineral production and consumption. In support of *The Green Plan*, EMR will undertake programs that improve the quality of the environment through environmentally sound research and development. It will also encourage the public, industry, utilities and governments to adopt measures that, while market-based, are also environmentally worthwhile in their own right.

Under *The Green Plan* action strategy, $3 billion will be spent over five years. This funding will encompass a number of broad environmentally sensitive areas, including $850 million for clean air, land and water, $575 million for combatting global warming caused by the combustion of fossil fuels, and $500 million for education and science. The Plan states two important goals that relate directly to EMR activities: to stabilize national emissions of CO_2 and other greenhouse gases at 1990 levels by the year 2000, and to cap acid rain-related emissions in eastern Canada beyond 1994.

As a major participant in EMR's environment strategy, CANMET will foster the development of new technologies aimed at improving the environment. CANMET will also work to transfer these technologies by improving market analysis and penetration programs and by exchanging the latest available information regarding environmental technologies. Although funding under *The Green Plan* has not been specified, additional funding is expected for programs in the science and technology area, including the following key environmental initiatives.

Transportation: to improve overall vehicle efficiency (including the development of light-weight, corrosion-resistant materials) and provide alternative fuels while reducing harmful emissions.

Alternative Energy: to direct R&D activities toward those technologies required for liquid and gaseous fuel alternatives in the near-term (natural gas and biomass) and hydrogen, electrochemical and electrical alternatives in the long-term.

Environmental Protection: to work with the private sector and regulatory agencies to ensure environmental protection in the production, transport, processing and use of fuels.

Energy Efficiency: *End-use Combustion and Conservation* - to focus on improving the efficiency and environmental acceptability of the processing and utilization of hydro-carbon-type fuels with an overall regard for energy efficiency. *Industry* - to encourage, assist and contribute to R&D in the industrial and commercial sectors to meet energy-efficiency targets. *Buildings* - to improve the energy efficiency of buildings by aggressively transfering energy-efficiency technology to the building industry.

Energy Systems: to expand technological and information endeavours that find ways to recover the heat that is currently wasted in conventional fossil-fuel power generation. This recovered heat can be used for district heating and cooling.

Waste Management: to focus research on the treatment of solid wastes and effluent streams derived from energy processing, supporting the four precepts of sound waste management: reduce, re-use, recycle and recover.

The New Science: to help create an Environmental Science and Technology Action Plan. At the forefront of Canada's environmental action plan is the need to explore new ways of solving our domestic and global problems, to help us reach a state of sustainable development. The aim is to work with provincial partners and the private sector to support the demonstration and commercialization of environmental technologies. The overall requirement is to strengthen the nation's environmental science and technology.

The Green Plan proposes a series of initiatives: significantly increasing the commitment to environmental science and technology, both nationally and internationally; creating more comprehensive environmental regulations; and making environmental laws and regulations more enforceable.

Major Environmental Issues for EMR and CANMET

Key environmental issues can be grouped into those that affect either the atmosphere, the water or the soil. The development and use of energy, minerals and metals can affect the environmental quality of each of these.

Atmospheric concerns include global climate change, ozone depletion, acid rain and air quality. These concerns arise from the fact that the chemical composition of the atmosphere has changed as a result of human activity.

Global Warming

Global warming, or the greenhouse effect, is widely seen as the most serious global environmental challenge. The timing, extent, and severity of the greenhouse effect are still uncertain. However, there is a strong consensus among scientists, including the International Panel on Climate Change, that the effects of global warming will be significant. The key factor is that the gases that contribute to the greenhouse effect, notably carbon dioxide, methane, nitrous oxide, ozone and some chlorofluorocarbons (CFCs), are accumulating at a rate that could trigger significant changes in global climate by the middle of the twenty-first century. Some global climate models predict increases in mean global temperatures of between 1.5 and 4.5 degrees Celsius, and rises in sea level of between 0.3 and 1.0 metre. These changes could have devastating effects on the world's economic, social and ecological systems. The international scope of the issue poses a significant challenge to all nations.

The key concern for CANMET is the emission of carbon dioxide from the combustion of carbon-based fuels, especially fossil fuels. CANMET's technological response is to develop ways to use carbon-based fuels more efficiently, thus reducing the amount of carbon dioxide produced. CANMET is also developing alternative fuels and energy sources that produce less carbon dioxide than conventional fuels, or none at all. Another important thrust is to develop ways to use energy more efficiently, thus reducing overall demand for carbon-based fuels.

Ozone Depletion

The stratospheric ozone layer protects life from the sun's harmful ultraviolet rays. Its depletion results from the decomposition of CFCs and associated photochemical reactions in the stratosphere.

CANMET is researching alternatives to CFCs and heat pump applications.

Acid Rain

Acid rain is caused primarily by emissions of sulphur dioxide and nitrogen oxide from non-ferrous smelting plants, and the combustion of fossil fuels (especially during electrical power generation). In affected regions, surface waters, soil, and groundwater have become acidic, to the detriment of plant and animal life, and to human-made and natural structures.

CANMET is responding to acid rain by developing technologies that reduce the quantities of the oxides emitted during smelting and fuel combustion.

Air Pollution

Poor outdoor air quality is caused by urban air pollutants that originate from the exhausts of automobiles and other vehicles, industrial and power plant emissions, and domestic heating sources.

CANMET's technologies reduce the level of these pollutants. For example, CANMET is developing alternative transportation fuels, such as natural gas and electricity, that emit fewer pollutants than conventional fuels. Increased efficiency of industrial and domestic energy use also reduces pollutant levels.

Poor indoor air quality is caused by an inadequate circulation of fresh outdoor air into buildings, and the gases emitted by the multitude of materials used in buildings and their furnishings.

CANMET's efforts to combat poor indoor air quality include the development of heat exchangers, which allow fresh air to be introduced in winter without the heat loss normally incurred.

Water Quality

Water-quality concerns most relevant to EMR result from tar sands processing, oil spills and the effects of hydrocarbon exploration and development. Other important water-quality issues related to the production or use of energy and minerals include the discharge of process water from thermal power plants, and contamination by trace elements. Of particular concern is acid mine drainage, produced by acidic run-off from mine and mill tailings. This drainage can devastate ecosystems some considerable distance from the source of the drainage.

Water quality can be improved with technologies that minimize contamination from energy and industrial processes, and capture and treat the effluent from mines and mills. CANMET's Mine Environment Neutral Drainage program, carried out jointly with industry and provincial governments, aims to develop technologies that reduce acid mine drainage and overcome its adverse effects.

Soil Contamination

Soil contaminants such as pesticides and heavy metals (nickel, zinc, iron, arsenic, mercury and sulphur) become toxic when released in excessive quantities into an ecosystem. In addition, radioactive and other solid wastes must be carefully managed in order to prevent soil and water contamination.

An important element in CANMET's research is overcoming such contamination by developing technologies that reduce or eliminate the release of these residues and wastes.

A major aspect of the environmental challenge is the link between environmental effects and the future health of Canada's economy. Unless technologies are developed that overcome the adverse environmental impacts described above, the future development of Canada's minerals and energy industries could be severely curtailed. These industries make a major contribution to Canada's economy; without them, Canada's economic well-being will be adversely affected.

Health and Safety

Ensuring public and occupational health and safety are key aspects of economic development. Among the current concerns are safety in underground mining because of such hazards as rock-bursting in deep mines, and emissions from underground vehicles, especially diesel-powered ones. Other issues include preventing explosions in coal mines, and ensuring the safe use of explosives for mining and industrial purposes. The public's safety in the use of fireworks and other pyrotechnic devices is important, as is general safety in the use of such fuels as compressed natural gas and propane. Detection and control of radon and other radioactive substances, in mining, industrial use and in domestic situations, is an important long-term health issue for CANMET.

CANMET is helping to resolve these health and safety issues in a number of ways. These include: developing technologies that predict and control rock-bursting; developing technologies that collect and neutralize harmful diesel emissions; developing, testing and certifying flameproof equipment for use in flammable atmospheres; testing and certifying pyrotechnic devices; developing standards, materials and equipment for the safe storage and use of gaseous transportation fuels; and developing equipment for calibrating radiation detectors.

The Energy Challenges

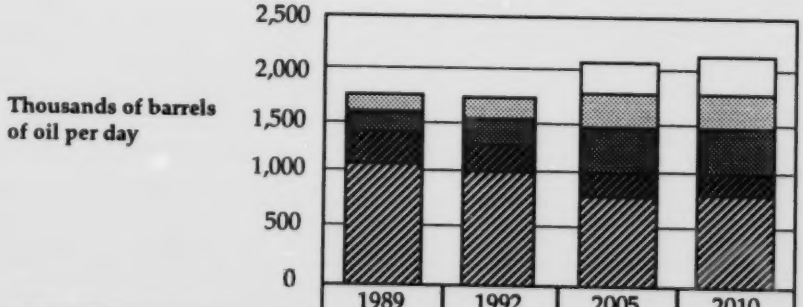
Canada has the most energy-intensive economy of the leading industrial countries, and is also a major energy producer. EMR's long-term energy policy maintains a wide range of energy options, including fossil fuels, nuclear power, alternative energy sources and conservation.

Oil

By the end of the century, international supply and demand forces should lead to significant increases in real oil prices, as rising consumption drains off excess capacity and non-OPEC conventional oil production decreases. It is possible that instability in the Middle East, as exemplified by the Iraq-Kuwait crisis, could drastically accelerate this trend.

In Canada, EMR expects that conventional oil production will decline in the mid-1990s because of falling established reserves and fewer reserve additions. Supply of oil from oil sands and frontier supplies will thus increase dramatically, as illustrated in Figure 3.1.

Figure 3.1
Canadian Oil Supply Forecast



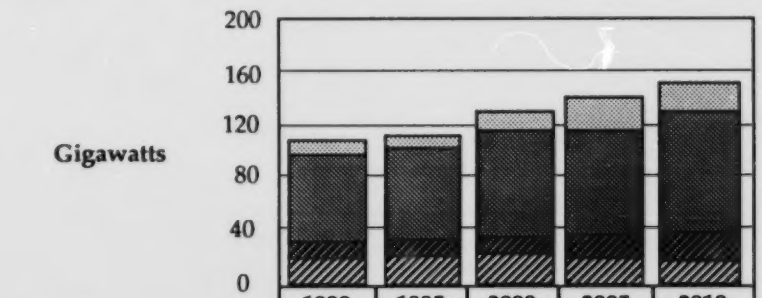
	1989	1992	2005	2010
Total	**1,749**	**1,730**	**2,057**	**2,073**
Offshore			351	351
Bitumen	136	175	352	406
Synthetic	211	211	367	367
Conventional/Heavy	302	294	235	215
Conventional/Light	1,100	1,050	752	734

Source: Energy Sector, Energy, Mines and Resources Canada, January 1990

Electricity

Electricity is expected to be Canada's fastest-growing energy carrier and source of energy exports over the next 30 years. By 2005, generating capacity is expected to have grown by almost 35 percent from 1990 levels, and it is expected to increase another 10 percent by 2010. Figure 3.2 illustrates the total electrical generating capacity in Canada, by energy sources.

Figure 3.2
Canada's Total Electrical Generating Capacity



	1990	1995	2000	2005	2010
Total	102.2	115.8	124.3	137.5	146.9
Coal	18.4	20.5	22.2	19.6	18.1
Nuclear	12.9	15.5	15.5	18.2	20.7
Hydro	58.5	64.7	72.2	80.7	88.5
Other	12.4	15.1	14.4	19.0	19.6

Source: Nuclear and Electricity Branch, Energy, Mines and Resources Canada, October 1990

Natural Gas

Natural gas is expected to be one of the fastest growing energy sources in developed market economies, until the end of the century. However, an important constraint on Canada's ability to produce and export increased quantities of natural gas is the present pipeline system, much of which is well into its design life.

Thermal Coal

Despite growing environmental concerns, world demand for thermal coal is expected to rise in the 1990s. In Canada two key environmental factors could affect the use of thermal coal. One is the emission of sulphur oxides from coal burning because of its contribution to acid rain. The other is the emission of carbon dioxide from coal burning, because of its contribution to global warming.

Renewable Energy

Renewable energy sources are already an important part of Canada's energy mix. The major contribution at present is through large-scale hydro power generation and the use of wood as an industrial fuel, particularly in the forest industry. In the future, the share of such renewable energy sources as small-scale hydro, wind, solar and tidal energy, as well as of biomass, is expected to become more important, because of the benefits that renewable energy offers. Apart from the virtually inexhaustible resource that renewable energy represents, these benefits include increased regional development and reduced demand for imported oil. Especially important are the environmental benefits that renewable energy offers, compared to conventional energy sources. These environmental benefits would become even more apparent if energy production and use were priced to include environmental damage (some countries are doing this).

Energy Efficiency

Canada has the highest per capita energy consumption in the world. While this is partly due to the structure of our economy, and partly to our climate, energy inefficiencies also play a role. Canadians have made progress in energy efficiency in the last 10 years, but more can be done in the industrial, building and transportation fields. Moreover, information technology, biotechnology and advanced materials offer cross-sectoral opportunities for improving energy efficiency.

Energy Infrastructure

An important energy issue for both Canada and the United States in the 1990s will be the development and maintenance of the North American infrastructure for processing and transporting oil and gas. The ability to extract, process and transport non-conventional oil and natural gas depends critically on the presence of an efficient, modern pipeline infrastructure. Heightened environmental awareness will make the exploitation and transportation of natural resources in the Arctic, offshore, and indeed, everywhere in Canada, more difficult. As noted above, many parts of the existing pipeline network are well into their design life, which complicates the problem of assuring that the delivery infrastructure meets the demands placed upon it.

CANMET is responding to these energy challenges in a variety of ways. Significant efforts are being devoted to developing technologies that will support the increased development of the oil sands. These include geotechnical developments to aid underground production, and improved treatment and storage of the large quantities of waste materials that result from oil sands upgrading. CANMET is developing and demonstrating technologies for burning coal more cleanly; one such technology is fluidized-bed combustion, which reduces emissions of nitrogen oxides and carbon dioxide, and permits the capture of sulphur found in coal before it forms sulphur oxides.

Developing the technologies to exploit renewable energy effectively is a major area of CANMET's work. Significant among these are processes to convert biomass into gaseous fuels and liquid fuels suitable for transportation. Solar and wind power technologies are also important aspects of CANMET's work.

In energy efficiency, CANMET is developing technologies that significantly reduce the demand for energy in domestic, commercial and industrial applications, including heating, cooling and power technologies. CANMET's work in energy systems, such as combined heat and power, also offers significant potential for increased overall efficiency of energy use.

With regard to infrastructure for developing and delivering oil and gas, CANMET's technologies will increase the life of the pipeline system, and contribute to safer oil production in remote and offshore regions.

The Minerals and Metals Challenges

Canada is the world's third-largest producer of minerals and metals. But the Canadian mining industry suffered severely from low global prices and abundant supplies during most of the 1980s. More recently, the industry has benefitted from the higher prices and substantial improvement in productivity achieved since the 1981-82 recession. However, a slowing global economy, falling commodity prices, rising domestic business costs, and an appreciating Canadian dollar suggest that the mining industry's prospects will be less promising in the early 1990s, although a full-scale collapse of prices and markets is not expected.

Over the longer term, a number of key trends will affect the industry. These are:

- **heightened competition in international markets from other suppliers, notably developing countries, Australia and Eastern European nations;**
- **the decline in Canada's ore reserves for many major metals;** Unless we significantly increase exploration expenditures early in the new decade, Canada will not be able to maintain its share of world output beyond the mid-1990s; This problem is exacerbated by the current emphasis on exploring for gold, because of its relatively high value, rather than for the base metals that will be required to sustain the present segment of Canada's economy that is built around these metals.
- **the growing impact of technology on supply and demand in global minerals and metals markets;** Demand for many industrial raw materials, especially metals, will continue to decrease due to technological advances that reduce the amount of minerals and metals used in manufacturing. On the supply side, the development and

increasing popularity of advanced industrial materials, such as polymers, ceramics and various synthetic materials, could result in significant displacement of base metals in a variety of applications by the year 2000;

- **the environmental challenge faced by the minerals and metals industries, as previously outlined;**
- **the lack of skilled workers available to the mineral and metals industries; and**
- **the need to recycle and reuse industrial materials.**

CANMET dedicates an important part of its programs to these challenges. Improved mining and processing technologies will help extend the economic life of Canada's existing ore-bodies. Improved metals-processing and fabricating technologies will help traditional materials maintain their markets against competition from newer materials such as plastics and ceramics. Technologies are being developed, as described above, to ensure that Canada's minerals and metals can be produced and used without unduly affecting the environment. Recycling and reuse is increasingly being considered as an integral part of the development of new technologies for producing and using metals and other materials.

CANMET is also contributing to the wider effort of encouraging young people to train for the minerals and metals industries. CANMET supports students in their graduate studies, and is helping to develop information and training kits for use in schools.

Economy and Economic Policy Challenges

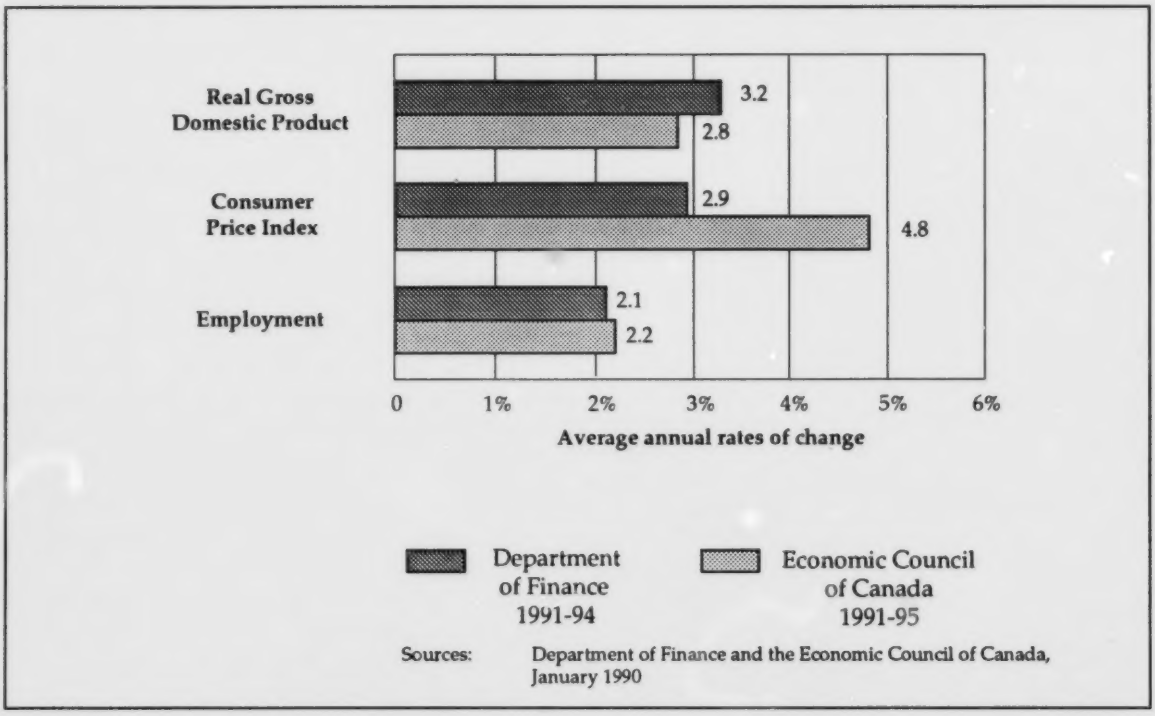
The performance of the Canadian and global economies, and the Government's trade and tax policies, will play an important role in shaping CANMET's external policies in the 1990s.

The global economic system is characterized by increased volatility. According to economic forecasters, however, a full-scale global recession is unlikely to occur within the next several years. The outlook for global trade is also reasonably favourable.

Economic Issues

The short-term prospects for the Canadian economy are among the least favourable of all of the industrial countries. Canada's medium-term prospects are somewhat better, according to forecasts on economic growth, inflation and employment by the Economic Council of Canada and the Department of Finance, as illustrated in Figure 3.3.

Figure 3.3
Canada's Medium-term Economic Forecasts



Sources: Department of Finance and the Economic Council of Canada, January 1990

Economic Policies

Most forecasters agree that the Canada-U.S. Free Trade Agreement (FTA) will have a positive, although relatively modest, impact on economic growth and industrial productivity in Canada. For the Canadian energy, minerals and metals industries, the key benefits will take the form of:

- encouragement for increased secondary processing and the development of higher value-added products;
- productivity gains through increased economies of scale and greater product specialization; and
- greater opportunities to sell specialized services related to the energy, minerals and metals industries in the U.S. market, as a result of freer trade in services and easier cross-border travel by business people and professionals.

Implementation of the Goods and Services Tax (GST) is an essential part of the Government's overall fiscal and economic management

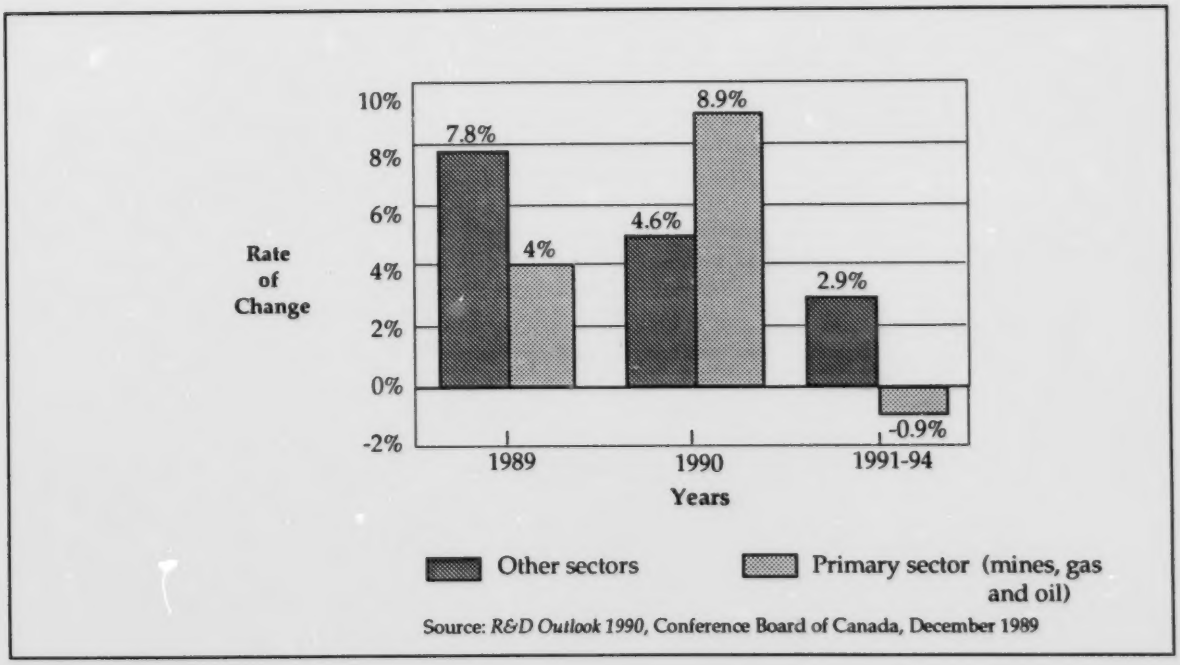
policy. Because both business-to-business and export sales will be exempt from the tax, the GST will remove the current indirect tax burden on investment goods and exports. This will benefit the energy and mining industries in the 1990s.

The deficit will continue to be a key government preoccupation. Despite tax increases and spending cuts over the past several years, the deficit remains in the range of $30 billion, and the ratio of debt to gross domestic product continues to rise.

R&D Spending Intentions of Clients

Tougher foreign competition, coupled with the continuing volatility of the global economy, will place Canadian resource industries in an environment characterized by a high degree of uncertainty. This will deter some firms from making long-term investments in technology, R&D and capital expansion. For many Canadian firms and industries, the primary challenge will be to quickly access and absorb advanced technology, rather than to develop new technology. Given these conditions, technology diffusion and absorption can be seen as critical challenges for Canadian industry.

Figure 3.4
R&D Spending Intentions of Companies in Primary Sector and Other Sectors



Source: *R&D Outlook 1990*, Conference Board of Canada, December 1989

A recent Conference Board of Canada survey predicted, for the early 1990s, a slight contraction in nominal R&D spending levels by the mining, oil and gas industries in Canada. If these scenarios are borne out, CANMET will face greater challenges as it strives for increased cost recovery and pursues more joint research initiatives with clients. Figure 3.4 illustrates the R&D spending intentions of CANMET's client sector relative to the other sectors of the economy.

Changes in the Public Service

There is a strong climate of change in the Public Service of Canada. A key aspect of this climate is the recognition that the procedures and cultures of the last several decades are not always appropriate today. The demands on public service institutions, including CANMET, are that they respond rapidly and effectively to the needs of their clients, both within and outside the Government. They must also continue to provide better service with fewer resources.

One initiative is Public Service 2000, a major review of the processes of the federal bureaucracy. Its purpose is to simplify government operations and improve service to the public.

A related initiative within EMR is the development of a renewed mission. This exercise involves all EMR's employees in a "bottom up" analysis of the goals, objectives and culture that EMR must adopt if it is to serve Canada properly in the next century. A key outcome will be a renewed, strengthened team spirit in EMR and its constituent agencies, including CANMET.

At the same time, the way the federal government manages its science and technology activities has been carefully assessed by the National Advisory Board on Science and Technology, which is chaired by the Prime Minister. One finding of this assessment is that the Government's science and technology establishments must have greater autonomy and administrative freedom to manage their resources efficiently. Without this freedom, it will be increasingly difficult for them to produce the high-quality research and technology development that Canada requires of them.

CANMET is building on these initiatives to enhance its present status as a government technology centre. We are discussing these proposed changes with EMR's management and the central government agencies, especially Treasury Board. The key elements of CANMET's proposal are described on page 40.

4 RESEARCH AND DEVELOPMENT THRUSTS FOR CANMET

Research and Development Thrusts for CANMET

Chapter Three describes the challenges that CANMET faces, and outlines the ways CANMET intends to meet them. This chapter describes how these responses will be undertaken in the following strategic areas: energy production; energy end-use; energy systems; minerals and metals production; minerals and metals end-use; and enabling or strategic technologies.

Energy Production

During the planning period, CANMET's energy R&D programs will be balanced between traditional and alternative energy sources. We will place a strong emphasis on those programs that reduce adverse environmental impacts.

Cleaner and More Efficient Combustion of Fossil Fuels

Environmental and productivity considerations are the impetus behind CANMET's research into cleaner and more efficient fuels. Efficient combustion requires less fuel and results in fewer harmful emissions per unit of usable energy. An important and urgent part of the work in this strategic area will be to develop innovative ways to burn coal more efficiently and cleanly, in coal-fired power stations, for example.

Transportation Fuels

Transportation is a major energy consumer and is a significant contributor to air pollution and greenhouse gases.

Alternative transportation fuels offer a partial solution to these problems. Propane is used widely in Canada, an environmental improvement over conventional fuels. Natural gas, as well as being an abundant domestic fuel, promises important environmental benefits. Natural gas-powered vehicles are already available, but further research and development of refuelling and vehicle conversion equipment is needed to encourage increased market penetration.

Similar opportunities exist in methanol, ethanol, hydrogen and electrochemical technologies. For example, hydrogen, as a fuel, if its production is not significantly dependent on fossil fuels, is an almost pollution-free energy carrier. Hydrogen could be an important long-term alternative to oil-based fuels, upon which the transportation sector is so heavily dependent.

At the same time, CANMET will continue its research into improving the environmental soundness of conventional transportation fuels.

Diversification of Energy Resources

Research into energy diversification indicates both environmental and economic benefits. For example, biomass-based fuels can be produced locally, and because they involve carbon recycling, they contribute little or nothing to the greenhouse effect. As well as the alternative transportation fuels mentioned above, wind, small-hydro and solar technologies are other areas of research from which significant environmental benefits could be realized.

During the planning period, CANMET will commission a new laboratory at Varennes, Québec, that will be responsible for carrying out part of CANMET's R&D in this area.

Quality of the Environment

Apart from the environmental benefits that will come from improved fossil fuel combustion and diversification of energy resources, there are several other important energy-related areas of R&D that will benefit the environment. These include: the treatment of solid wastes and effluent streams from coal, tar sands and oil processing plants; and control of emissions from power plants.

Energy Systems

Potentially very large improvements in the way Canada uses its energy can be made by using the heat that is often wasted in conventional power generation using fossil fuels. If this heat were used for municipal district heating and cooling, there would be two key benefits. First, the overall demand for primary energy would drop. Second, the amount of carbon dioxide and other pollutants produced per unit of usable energy would drop significantly.

During the planning period, CANMET will expand its present efforts to overcome the technical and attitudinal barriers that inhibit wide use of these energy systems. These barriers include: lack of awareness of the environmental benefits of such systems; lack of awareness of technological developments in combined heating, cooling and power applications; and lack of a structure for effective cooperation between electricity producers, municipalities, developers and energy users. The proposed program will disseminate information, improve technology, and encourage demonstrations of energy systems.

Energy End-use

Although increasing energy production is important, energy efficiency and conservation cannot be neglected, for productivity and environmental reasons.

Energy Efficiency in Buildings

The buildings sector represents approximately 34 percent of energy end-use in Canada. Over the past five years there has been considerable upgrading in the energy-efficiency standards for residential buildings. The technologies necessary for a similar upgrading of buildings in the commercial sector need to be developed, and existing technologies including heating, cooling and lighting technologies must be fully commercialized.

Energy Efficiency in Transportation

Road vehicles are significant consumers of energy, especially oil-derived fuels. They are also a major source of pollutants, including the precursors of acid rain and greenhouse gases. Improving road-vehicle efficiency through technological innovation will produce both economic and environmental benefits.

Research and Development Thrusts for CANMET

Industrial Efficiency

The Industrial Energy R&D (IERD) program has proved the effectiveness of providing funding assistance to develop technologies for the improvement of energy efficiency in many industries. For greater impact, CANMET will become more proactive in encouraging energy efficiency improvements in industries that use large amounts of energy. CANMET will analyze sectors to identify key opportunities for reducing fossil fuel and electricity consumption. Potential clients will be identified for the development of more energy-efficient industrial process technologies.

Minerals and Metals Production

Research and development related to minerals and metals production will focus on safe and innovative mining, efficient minerals and metals processing, and quality of the environment.

Health and Safety in Mining

An important and ongoing strategic area of work for CANMET will be research to improve health and safety in mining, especially underground mining. Key research topics include ventilation circuits, mining environments, and the certification of mining equipment for gassy atmospheres and for materials covered by the *Canada Explosives Act*.

Innovative Underground Mining

Mining underground, in a hard-rock environment, is a cyclical process involving the drilling, blasting, and "mucking" of ore, and the stabilizing of the surrounding rock. To maintain a competitive edge, the hard-rock mine of the future must be highly automated and well-monitored, and operate as far as possible on a continuous cycle, rather than the present cycle of rock breaking followed by rock moving.

In partnership with industry and other laboratories, CANMET will work on developing the technology and equipment necessary for the implementation of continuous mining and for monitoring and controlling all operational aspects of tomorrow's mine, (the smart mine). An important part of this work will be carried out at CANMET's new mining research laboratory at Val D'Or, Québec, which will be commissioned early in the planning period.

Efficient Minerals and Metals Processing

CANMET will participate in the development of improved equipment and operating methods to increase productivity in Canada's minerals and metals processing operations. CANMET's continued work in this area will include improved column-flotation and gravity-separation techniques for ores. CANMET will also use computer modelling and simulation to help design improved processes in areas such as steel production and fabrication, and metal casting. Better ore-beneficiation techniques, and the application of improved technologies in extractive metallurgy, will help increase productivity. Efforts to improve the corrosion-resistance and wear-resistance of minerals and metals-processing equipment will also be important areas of work.

Environmental Quality

An important focus for CANMET's research will be the treatment of solid wastes and effluent streams from minerals and metals processing plants. MEND, the successful program on mine environment neutral drainage, will continue, with strong participation from industry and provincial governments. The objective of MEND is to reduce the impact of acid run-off from mines on local vegetation and soil quality.

CANMET will also strive to improve environmental control technologies in facilities such as smelters and foundries.

Minerals and Metals End-use

Better products, increased recycling and reuse, and added value will be the focus of research pertaining to minerals and metals end-use.

Minerals and Metals Products

CANMET will continue to research ways to improve the properties and attractiveness of traditional minerals and metals products that face increasing competition from substitutes. These products will also be used as components for the development of advanced industrial materials.

Finding new uses and applications for traditional materials will also be important. Tougher materials increase people's confidence in the mechanical integrity of pipelines, arctic ships, offshore structures, and processing plants.

Research will also focus on the reuse and recycling of minerals and metals products.

Added Value

Canada currently fails to capture many of the economic benefits inherent in its rich resource base. Most minerals and metals leave the country in the form of concentrates and primary metals. Through its Further Processing Program (cost-shared 50/50 with industry), and joint research initiatives, CANMET will encourage more processing and fabrication activity in the Canadian minerals and metals industries.

Strategic Technologies

Information technology, biotechnology, and advanced materials enable advancement in all of CANMET's R&D activities, including environmental and productivity research.

Information Technology and Artificial Intelligence

Increased use of information technology is the key to increased productivity, process efficiency and quality, and to reduced environmental impact in mining, metal and energy operations. CANMET has considerable expertise in many aspects of this field (such as process control, expert systems, and statistical process design) and will be applying these in collaboration with clients to an increasingly broad range of processes.

Biotechnology

CANMET will enhance its expertise in applying biotechnology to the mineral and energy industries. The application of existing knowledge to key energy areas, such as the processing of heavy oils and bitumens, will become important. Moreover, the role of biotechnology in the treatment of waste from both minerals and energy production will increase. Biotechnology will also continue to be used in work on the conversion of biomass into fuels and chemicals.

Advanced Materials

Advanced materials will have an important impact on Canada's competitive position. Advance metallic materials under development in the planning period include metal matrix composites and advanced alloys. R&D will also be carried out on advanced forming of these materials, to increase efficiency of production. Development of ceramics is another key thrust. We intend to raise awareness of the potential uses of ceramics and provide assistance to develop what is still a fledgling industry in Canada.

5 MANAGERIAL AND ADMINISTRATIVE INITIATIVES

Managerial and Administrative Initiatives

The strategic directions set for technology development are supported by several key managerial and administrative initiatives in: human resource issues; linkages and relationships; general processes and systems; geographical considerations; and structural changes in the public service.

Human Resource Issues

Staff motivation is an essential element in the success of any organization. It is especially critical in CANMET because of the major changes under way, including reorganizations in most of the divisions and modifications in our way of doing business. Strategic approaches to enhancing employee morale will include using effective rewards for meritorious work, maintaining clear communications at all levels, encouraging ways in which all staff can play a role in planning CANMET's future, and encouraging staff mobility and experience through such means as EMR's new Assignment Program.

CANMET will place a stronger emphasis on training to ensure that staff can develop the career skills they need to progress and contribute to CANMET. The training program will emphasize management and interpersonal skills.

The future supply of scientific and technical staff is becoming a concern. To help ensure future supply, CANMET will promote science and technology in industry and in public forums. We will also focus on strategic recruitment, skills upgrading, increased financial support of graduate students, and student employment. Moreover, where appropriate, CANMET will help to develop educational material.

Improved mechanisms for secondments and interchanges will be developed, since exchanges contribute to the vitality of CANMET and technology transfer.

Linkages and Relationships

CANMET will work during the planning period to further improve its relationships with its clients. Key objectives will be to deliver quality projects on time and within budget, to let research contracts quickly and simply, and to set up other financial links with clients with minimum delay—particularly contribution agreements. Moreover, increased liaison at senior and intermediate levels will help CANMET to better understand the needs and motivations of clients.

CANMET's relationships with central agencies of the federal government will continue to be the focus of concerted effort during the planning period, as will clear, strong links with EMR's central policy and administrative groups. A key issue to be discussed with these groups is CANMET's organizational status. This will be reviewed and, where necessary, revised, to enable CANMET to meet the need for future technology development in Canada's minerals, metals and energy sectors. Particularly important will be greater administrative and financial flexibility.

Linkages with other federal and provincial government departments and agencies will also be important. For instance, CANMET will cooperate extensively with other departments such as Environment Canada and Industry, Science and Technology Canada. Moreover, cooperation with the Standards Council of Canada will be enhanced.

CANMET will continue to ensure effective relationships and linkages with the Panel on Energy Research and Development (PERD), which is the major source of CANMET's funds for energy R&D (about $50 million and 133 person-years annually). CANMET's relationship with the PERD program will continue to be reviewed to ensure that it meets the needs of both CANMET and PERD.

CANMET will seek improved cooperation with external research groups, including industry and provincial research organizations, and other research groups in North America, Oceania and Europe.

Synergies between CANMET research groups will be consolidated in such areas as:

- recycling and safe disposal of waste minerals;
- alternative and conventional fuels;
- application of mineral processing techniques directly in the mine;
- commercial building efficiency, efficient furnaces and heat pumps;
- better use of fuels through improved use of materials;
- materials for use in mining;
- surface science diagnostic techniques to be applied in more diverse fields; and
- the integrity of energy systems.

General Processes and Systems

New intellectual property policies facilitate CANMET's work with the private sector. CANMET will continue to work with other departments and Treasury Board to develop a system that will better meet the mission of the government's technology centres.

CANMET will enhance its information and marketing activities to ensure that technical information and products are widely disseminated, and that programs and capabilities are extensively publicized. The goal will be to broaden existing national and international marketing efforts. In addition, face-to-face marketing will be strengthened.

CANMET will improve its management information systems so that they contribute fully to efficient and effective management. The existing systems will be refined to provide project and management information more clearly and promptly.

Health, safety and environmental reviews will be fully integrated into CANMET's management systems.

Geographical Considerations

CANMET will review the distribution of its facilities and programs to ensure that an appropriate balance exists among Canada's geographical regions. In the past year, work has progressed in establishing two new laboratories in Québec, at Varennes and Val D'Or. In addition, the Coal Research Laboratory in Devon, Alberta, will be restructured to form the basis of a new and expanded CANMET West Operation linked directly to other CANMET laboratories. Other opportunities to strengthen CANMET's operations in western and eastern Canada will also be reviewed.

CANMET recognizes that it must develop, acquire and transfer technology to the international community. During the planning period, CANMET will enhance its international activities, allowing Canadian technologies to become better known and respected in other countries. Moreover, it will facilitate technology inflow in Canada, and subsequent rapid diffusion and absorption.

Structural Changes in the Public Service

In 1990-91, a number of government-wide, departmental, and sectoral studies and initiatives have been developed to revitalize the public service. They include Public Service 2000, the Departmental Mission Project and the Enhanced CANMET Proposal. Each of these complementary initiatives is designed to revitalize the public service so that it responds more rapidly and effectively to the needs of its clients. These initiatives will have a major impact on CANMET's operations during the 1991-94 planning period.

Public Service 2000

The primary objective of Public Service 2000 is to create a more outward-looking public service, one that is capable of adapting to change, and that is committed to serving the public.

The main recommendations can be grouped around a number of themes. We must focus much more on service to the public. To do this, we must renew the public service in terms of: career development and training; deregulation and empowerment; and enhanced accountability.

Departmental Mission Project

The Deputy Minister has appointed a council of 45 people who represent all levels, working groups and sectors of the Department. The councillors are working with the Deputy Minister and have consulted with all employees of EMR to facilitate a communication process that improves the focus and effectiveness of the Department. To this end the councillors have:

- obtained input on the organization's management and business values;

- identified issues and challenges facing the organization; and
- obtained suggestions that will influence both the drafting of a mission statement and how issues are to be addressed.

The project was launched in June 1990. It culminated in January 1991 with the adoption of a mission and action plan by Council and Departmental Managers at their conference entitled "Living the Mission."

CANMET's New Institutional Framework

Public Service 2000 and the Mission Project will lead to important opportunities for CANMET. CANMET has changed significantly its organizational culture and way of working since becoming a designated government technology centre. We are currently negotiating with EMR and Treasury for more flexibility in administrative systems. In return, CANMET has increased its targets for cost recovery and leverage on funds. As a result, Canada will benefit from a stronger, internationally acclaimed technology centre, and will receive more R&D for each dollar invested in CANMET.

Changes to CANMET's Institutional Framework

CANMET now emphasizes service to its clients within and outside government, and especially industry. Our programs, although they include a major effort to develop long-term technology, strongly emphasize applied R&D. Only 10 percent of CANMET's efforts are allocated to unsponsored R&D, that is, R&D that does not directly attract client support. A significant part of CANMET's costs is now recovered, and an even larger part of our work is highly levered by attracting matching funds from industry and governments.

The institutional framework within which CANMET operates has not changed significantly. Staffing levels are still controlled independent of operating and capital budgets, and take no account of increased opportunities to carry out additional work wholly or partly funded by outside clients. Budgets are still allocated in specific areas—specifically, in capital, operating and maintenance, and grants and contributions—with little flexibility to move funds between these categories when changing work requirements demand. Budgets are tied to fiscal years, with little flexibility to advance or defer expenditures between years, even though this may be financially advantageous. Apart from salaries, which are fixed by negotiations between public service unions and the Treasury Board, CANMET has received no inflationary increase in its budgets for most of the last decade. As a result, CANMET's resources have been significantly eroded in real terms.

Reporting and audit demands are considerable, and ignore the fact that CANMET's chief means of quality control today is client satisfaction. Staffing and financial services are provided centrally, and do not always respond as quickly and effectively as CANMET's new, client-oriented organization requires.

These problems are not unique to CANMET. Public Service 2000 found similar problems throughout the public service. The National Advisory Board on Science and Technology conducted a detailed review of the way federal science and technology institutions are managed; concluded that present administrative structures for these institutions are inappropriate, and did not encourage high-quality research and development.

If CANMET is to flourish and serve Canadian industry well in the future, there must be changes in the institutional framework within which CANMET operates. In particular, CANMET must escape the erosion of its real funding being caused by lack of inflation protection. CANMET also requires efficient financial and other support services, and greater flexibility in allocating its financial resources.

CANMET proposes to negotiate with EMR and Treasury Board to improve the institutional framework that governs its operations. The changes sought are:

- one budget that covers salaries, capital, operating and other funds, with no restriction on movement between categories;
- full flexibility to move expenditures between fiscal years;
- continued negotiation of staff salaries with Treasury Board, with all increases to be reflected in CANMET's budget;
- some indexing of non-salary costs against protection;
- authority to retain all cost-recovery revenues, and apply them first to offset inflation and then to fund increased R&D;
- freedom to dispose of intellectual property arising from CANMET's work; and
- no control of person-years.

CANMET will also strengthen its links with its internal (government) clients, especially EMR. To do this, we will establish a new Deputy Minister's Advisory Committee to CANMET, to complement the existing Minister's National Advisory Council to CANMET (MNACC). The new committee will have links to MNACC; its members will include EMR's Assistant Deputy Ministers of Energy, Mineral Policy, Corporate Policy and Communications, and Finance and Administration. A key role of the committee will be to ensure that CANMET's programs properly reflect government policy, and that this policy in turn takes full account of CANMET's expertise in science and technology and their impact on the energy and minerals industries.

CANMET will also seek significant improvements in its financial and personnel services, and reduced reporting and evaluation requirements.

Given these changes, CANMET will increase its targets for cost recovery and leverage on funds. Canada will benefit from the reputation as a stronger, internationally-acclaimed technology centre, and will receive more R&D for each dollar invested in CANMET. Finally, the real cost of CANMET to the Crown will remain steady or decrease, unless CANMET is asked to take on additional programs.

6 RESOURCES

Financial Resources

Table 6.1 gives CANMET's sources of funds and expenditure categories for 1990-91 through 1993-94. Tables 6.2 and 6.3 provide information on CANMET resources by Branch. Details of resource allocations, by Division, are given in Part B of this plan.

Resource estimates are based on the following assumptions:

- PERD, which provides about 45 percent of CANMET's budget, will continue to supply this level of resources;
- salaries include 16 percent for fringe benefits and a 5 percent annual inflation adjustment; and
- no inflation protection is expected for capital, operating budgets and contracts.

Future program changes such as new mineral development agreements, negotiations on CANMET's future institutional framework, and the environmental initiative will significantly affect these resource estimates.

Human Resources

In the current three-year plan, CANMET will have to face some human resource management challenges to adequately fulfil its mandate. CANMET must:

- continue to build and broaden employee commitment to the new CANMET mission and strategy by establishing effective two-way communication;
- improve opportunities for employees to be assigned to different tasks for training and career development purposes;
- pursue the development of an innovative, service-oriented culture within CANMET;
- attract employees with specialized scientific training, given the declining university enrolment in science and technology and strong private-sector competition;
- put in place "succession" plans to alleviate continuity gaps resulting from an aging scientific population (currently 28 percent of CANMET's scientific population is younger than 40, while 32 percent is older than 50);
- meet particular training needs resulting from the new CANMET mode of operation (for example, marketing, presentation skills, interpersonal skills, project leadership and management, and intellectual property management);
- continue the establishment of regional laboratories in Varennes, Québec; Val D'Or, Québec; and Devon, Alberta;
- implement measures to meet governmental objectives in areas such as official languages, employment equity and occupational health and safety; and
- increase the efficiency and effectiveness of employees.

Table 6.1
Estimated Resource Allocations by Sources of Funds ($000)

Expenditure Category/ Allotment	1990-91	planned 1991-92	1992-93	1993-94
Person-years				
A-Base & Others	738.0	731.0	728.0	721.0
Energy R&D	120.0	120.0	120.0	120.0
Subtotal	**858.0**	**851.0**	**848.0**	**841.0**
Salary				
A-Base & Others	43,888.8	44,496.0	46,526.5	48,386.4
Energy R&D	7,519.2	7,520.4	7,894.8	8,289.6
Subtotal	**51,408.0**	**52,016.4**	**54,421.3**	**56,676.0**
Regular Operating				
A-Base & Others	8,345.0	8,676.0	8,854.0	9,029.0
Energy R&D	9,759.0	10,129.8	10,311.5	10,453.4
Incentive Bonus	1,703.0	2,807.0	2,315.0	2,315.0
Subtotal	**19,807.0**	**21,622.8**	**21,480.5**	**21,797.4**
R&D Contracts				
A-Base & Others	3,758.0	5,134.0	4,102.0	4,062.0
Energy R&D	19,665.1	17,207.9	16,981.2	16,892.3
Incentive Bonus	0.0	0.0	0.0	0.0
Subtotal	**23,423.1**	**22,341.9**	**21,083.2**	**20,954.3**
Capital				
A-Base & Others	3,680.0	7,095.0	4,797.5	4,717.5
Energy R&D	4,415.0	4,482.0	4,510.5	4,417.5
Incentive Bonus	0.0	1,067.0	1,067.0	1,067.0
Subtotal	**8,095.0**	**12,644.0**	**10,375.0**	**10,202.0**
Grants & Contributions				
A-Base & Others	225.0	262.0	262.0	262.0
Energy R&D	6,881.0	8,343.0	9,073.0	9,133.0
Subtotal	**7,106.0**	**8,605.0**	**9,335.0**	**9,395.0**
CANMET Totals				
A-Base & Others	59,896.8	65,663.0	64,542.0	66,456.9
Energy R&D	48,239.3	47,693.1	48,771.0	49,185.8
Incentive Bonus	1,703.0	3,874.0	3,382.0	3,382.0
Total	**109,839.1**	**117,230.1**	**116,695.0**	**119,024.7**

Table 6.2
Estimated Resource Allocations by Branch and Expenditure Category ($000)

		1990-91	1991-92	1992-93	1993-94
Fossil Fuels Technology Branch	Salaries	13,497.8	13,517.4	14,060.2	14,625.8
	Regular Operating	5,971.0	5,744.0	5,794.0	5,844.0
	R&D Contracts	6,997.0	6,159.9	6,548.2	6,509.3
	Capital	2,456.0	2,385.0	2,110.5	2,842.5
	Grants & Contributions	763.0	1,040.0	770.0	830.0
	Subtotal	**29,684.8**	**28,846.3**	**29,282.9**	**30,651.6**
Mineral Technology Branch	Salaries	23,548.1	23,709.0	24,892.9	25,799.8
	Regular Operating	6,008.0	5,870.0	5,895.0	5,905.0
	R&D Contracts	4,120.0	5,461.9	4,389.9	4,362.9
	Capital	3,906.0	7,342.0	4,974.5	5,104.5
	Grants & Contributions	0.0	0.0	0.0	0.0
	Subtotal	**37,582.1**	**42,382.9**	**40,152.3**	**41,172.2**
Efficiency and Alternative Energy Technology Branch	Salaries	4,358.4	4,494.0	4,723.7	4,968.0
	Regular Operating	2,350.0	2,644.0	2,739.0	2,749.0
	R&D Contracts	10,670.1	9,440.1	8,851.1	8,773.1
	Capital	1,029.0	1,591.0	2,021.0	811.0
	Grants & Contributions	6,225.0	7,437.0	8,437.0	8,437.0
	Subtotal	**24,632.5**	**25,606.1**	**26,771.8**	**25,738.1**
Policy, Planning and Services Branch	Salaries	9,706.3	9,991.6	10,424.9	10,946.8
	Regular Operating	5,408.0	5,905.8	6,092.5	6,339.4
	R&D Contracts	1,636.0	1,280.0	1,294.0	1,309.0
	Capital	694.0	540.0	483.0	658.0
	Grants & Contributions	50.0	60.0	60.0	60.0
	Subtotal	**17,494.3**	**17,777.4**	**18,354.4**	**19,313.2**
Assistant Deputy Minister's Office	Salaries	297.4	304.4	319.6	335.6
	Regular Operating	70.0	1,459.0	960.0	960.0
	R&D Contracts	0.0	0.0	0.0	0.0
	Capital	10.0	786.0	786.0	786.0
	Grants & Contributions	68.0	68.0	68.0	68.0
	Subtotal	**445.4**	**2,617.4**	**2,133.6**	**2,149.6**
CANMET Totals	Salaries	51,408.0	52,016.4	54,421.3	56,676.0
	Regular Operating	19,807.0	21,622.8	21,480.5	21,797.4
	R&D Contracts	23,423.1	22,341.9	21,083.2	20,954.3
	Capital	8,095.0	12,644.0	10,375.0	10,202.0
	Grants & Contributions	7,106.0	8,605.0	9,335.0	9,395.0
	Total	**109,839.1**	**117,230.1**	**116,695.0**	**119,024.7**

Capital Resources

In September 1988, Treasury Board approved the release, over five years, of $30 million to resolve essential health and safety and urgent asset-management concerns within the special-purpose buildings under EMR's custody. Some $26.8 million of these funds will be spent on CANMET facilities. These funds are part of the Finance and Administration Sector budget.

In addition, CANMET facilities should incorporate the most energy-efficient buildings and equipment technologies. Resources for this will be sought over the planning period.

The establishment of new regional laboratories will be a priority. CANMET has obtained from Treasury Board an additional $6 million for the 1990-95 period to establish a new mining laboratory in northwest Québec. Moreover, some $8 million in capital funds will be required to build the new Energy Diversification Research Laboratory in Varennes, Québec.

CANMET will also be spending approximately $8 million annually to upgrade its capital equipment assets, including laboratory, electronic data processing and transportation equipment.

Table 6.3
Person-year Allocations by Branch

	1990-91	1991-92	1992-93	1993-94
Fossil Fuels Technology Branch	223	220	218	216
Mineral Technology Branch	395	389	389	384
Efficiency and Alternative Energy Technology Branch	72	73	73	73
Policy, Planning and Services Branch	163	164	163	163
Assistant Deputy Minister's Office	5	5	5	5
Total	858	851	848	841

7 PERFORMANCE MONITORING

Performance Monitoring

CANMET's performance is monitored through regular reviews, internal monitoring of key performance indicators, and outside audits and evaluations.

Reviews

In addition to reviews by individual managers and division directors, CANMET programs are formally reviewed twice a year by the Assistant Deputy Minister. The first review takes place at mid-year to assess progress and to determine whether there will be any problems in meeting objectives. The second review occurs at the end of the fiscal year to evaluate how effective CANMET has been at meeting the year's objectives.

In addition, CANMET managers monitor the final cost and delivery date of projects, comparing these against forecast expenditures and projected milestone dates, which are recorded in CANMET's project management system. This helps to ensure that CANMET's laboratories are delivering what they promise, on time and within budget. Such performance is particularly important in cost-recovery and task-shared projects, which involve the time and money of both CANMET and its clients.

Key Performance Indicators

CANMET management uses a number of key performance indicators (KPIs) to monitor its programs. These indicators are compared each month with targets set for the planning period. Specific KPIs have been established for cost recovery, task-shared agreements, cost-shared agreements, patents and licences, and technology seminars. Early in the planning period, additional KPIs will be developed to monitor how we deliver on time and on budget, and to help us measure how we are "protecting" our long-term R&D effort. Other KPIs will also be considered to measure technology transfer activities in terms of market penetration and sales of new technologies.

Cost-recovery Revenue

The revenue from work performed directly for clients is a good indicator of the value that clients, especially the private sector, place on CANMET's expertise and facilities. Cost recovery increased from $1.6 million in 1987-88 to $2.3 in 1988-89. In 1989-90, CANMET surpassed its cost-recovery target to reach $4.7 million. Higher targets have been set for future years, but these targets can be achieved only if CANMET obtains substantial administrative and organizational flexibilities from the Department and central agencies through the negotiations on CANMET's future institutional framework discussed above. Canada's economic situation could also have a significant impact on the achievement of those targets. Additional consultations with clients are required, especially within the Explosives Division.

Table 7.1
Cost-recovery Targets ($000)

	planned 1989-90	actual 1989-90	planned 1990-91	1991-92	1992-93	1993-94
Mineral Technology Branch	2,620	2,689	3,580	4,625	5,815	6,905
Fossil Fuels Technology Branch	1,670	1,679	2,250	2,800	3,350	3,875
Efficiency and Alternative Energy Technology Branch	0	0	100	215	375	450
Policy, Planning and Services Branch	350	353	330	360	460	770
Total	4,640	4,721	6,260	8,000	10,000	12,000

Task-shared Agreements

Task-shared agreements describe research performed jointly with a client without any exchange of funds. Such work is an important indicator of the leverage CANMET is obtaining on its in-house research programs, as well as a measure of how relevant CANMET's research programs are to its clients. Client contributions to task-shared work increased from $5.4 million in 1987-88 to $6 million in 1988-89. In 1989-90, client contributions reached $10.7 million, well above the target of $8.5 million. The achievement of future targets will depend on clients' continued willingness to participate with CANMET on R&D projects. See Table 7.2.

Cost-shared Agreements

Cost-shared agreements include CANMET's contracts, grants and contributions to clients. Both the client's share and CANMET's share of these agreements is monitored. Client shares also indicate the value that clients place on CANMET's research programs. Up to 1989-90, only the client's share of contracts was monitored; starting in 1990-91, the client's share of grants and contributions will be monitored. See Table 7.3.

Table 7.2
Client Contribution to Task-shared Agreements ($000)

	planned 1989-90	actual 1989-90	planned 1990-91	1991-92	1992-93	1993-94
Mineral Technology Branch	4,675	5,620	5,500	7,750	9,200	13,350
Fossil Fuels Technology Branch	3,825	5,044	4,500	6,100	7,500	8,100
Efficiency & Alternative Energy Technology Branch	0	0	0	500	700	875
Total	8,500	10,664	10,000	14,350	17,400	22,325

Table 7.3
Client's Share of Cost-shared Agreements as a Percentage of Total Costs

Year	Planned %	Actual %
1987-88	23.8	25.8
1988-89	28.9	25.5
1989-90	34.4	37.9
1990-91	34.4	—
1991-92	37.5	—
1992-93	37.5	—
1993-94	37.5	—

Secondments and Interchanges

CANMET encourages its staff to work in the laboratories of its clients, especially industry, to benefit from the exchange of ideas and experience. Client employees are also encouraged to work in CANMET's laboratories for similar reasons. The key performance indicators include targets for such secondments.

Table 7.4
Secondments to and from CANMET (in person-years)

	planned		actual		planned							
	1989-90		1989-90		1990-91		1991-92		1992-93		1993-94	
	from	to	from	to	from	to	from	to	from	to	from	to
Mineral Technology Branch	6	5	5.2	9.4	9	7	8	9	8	9	9	11
Fossil Fuels Technology Branch	3	3	2.7	1.2	4	4	4	5	4	6	5	7
Efficiency & Alternative Energy Technology Branch	0	0	0	0	2	2	2	4	2	2	2	2
Total	9	8	7.9	10.6	15	13	14	18	14	17	16	20

Patents and Licences

Patents and licences granted are a measure of CANMET's success in developing technology that has actual or potential commercial value. The indicators that are monitored are actual grants of patents and licences, rather than applications.

Five years ago, only one patent and one licence were issued. In 1989-90, CANMET obtained 12 patents and issued 15 licences. We also developed a new intellectual property policy to facilitate patenting and licensing, and the transfer of technology.

Technology Seminars

As a technology centre, CANMET places considerable emphasis on marketing both its technology and its skills. Each year, seminars are held on technical subjects or, more generally, on the work of CANMET's laboratories. These seminars are often held in conjunction with other seminars, such as those of the provincial mining associations. The number of seminars and participants from outside CANMET are both monitored since they indicate the level of activity in this marketing-related area.

In 1989-90, CANMET organized 52 technology-transfer seminars. This involved 4,441 person-days of external participants.

Audits and Evaluations

Audits can provide valuable insights into the efficiency of operations. According to EMR's Internal Audit Report on CANMET in September 1989:

"It is the auditor's opinion that the initiatives taken, particularly the development of a Business Plan, strengthening of strategic and operational planning processes, implementation of several organizational improvements, establishment of an accountability framework, development of management information and project management systems, development of performance measurement, and implementation of methods to increase employee satisfaction, are contributing to the effective attainment of CANMET's objectives. Although not all of the initiatives have been fully implemented, it is clear that the changes made to date enhance CANMET's ability to fulfil the current mandate in an effective manner."

Evaluations

The success of a research project can be judged, to some degree, by how well it fulfils its objective. However, assessing the economic benefits derived from the same project is more difficult. For instance, if a project was judged to have met its objective of advancing knowledge, then the resulting economic benefits are, theoretically, incalculable. The same argument applies to research in support of policy development. Hence, economic-benefit analysis of this type of research is inappropriate.

Some research, however, can be evaluated using traditional economic analysis. This was done by Peat Marwick Stevenson and Kellog in 1989-90 for a number of CANMET projects. Their report, "Review of Selected CANMET Research and Development Projects," reviewed nine recently completed projects that were expected to be of financial benefit to Canada. Table 7.5 shows some of the more strategic data derived in this study. All data is in current dollars except for Net Present Value (NPV), which is in 1990 dollars.

The report also found that these projects had focussed reasonably on safety, regional development and environmental concerns. It also concluded that technology transfer had been successfully achieved in all cases.

The report suggested, however, that some caution be exercised when interpreting these results. For instance, the negative Net Present Value for the "Pressure vessel fabrication" project is due to factors beyond CANMET's control, such as the unexpected downturn in the Canadian petro-chemical industry. A similar decline in the market for uranium limited the economic returns from "Bioleaching of Uranium," a project that was judged technically successful. Finally, the report notes that two projects account for almost 90 percent of the Net Present Value for the nine projects, a normal characteristic of research and development activities.

Although it is important that economically justified projects be assessed economically, the results must be viewed with

Table 7.5
Benefit/Cost Results of Selected CANMET Projects

	CANMET Costs ($ millions)	Net Present Value ($ millions)	Leverage Ratio	Benefit/ Cost Ratio
Fossil fuel heating systems	15.1	23.2	N/A	2.5
Safety limits coking pressure	1.6	2.6	0.0	2.6
Pressure vessel fabrication	4.2	(1.5)	0.0	0.6
H_2S cracking of steel pipe	4.1	14.5	1.0	4.5
Rockburst project	4.2	229.0	2.9	14.8
Diesel exhaust cleaning	3.5	22.3	1.6	4.2
Bioleaching of uranium	2.5	6.4	1.1	2.2
Cementing materials	8.2	245.8	0.1	27.7
Monolithic packing technology	0.3	1.4	0.2	1.8
Total	43.7	543.7	0.97	—

considerable caution. At a minimum, the results must be judged in terms of the assumptions accepted at the time the project was approved. Equally important are the subsequent assumptions used in quantifying the economic benefits. Moreover, because of the nature of economically justified research, some projects may be less "profitable" than others, but by no means less important when judged by other criteria, such as the environment and health and safety. Therefore, economically justified projects are probably better analyzed as a block.

Finally, if the indicated benefit/cost ratios are at all indicative of market value, there appears to be some room to further increase industry's financial participation in CANMET research projects.

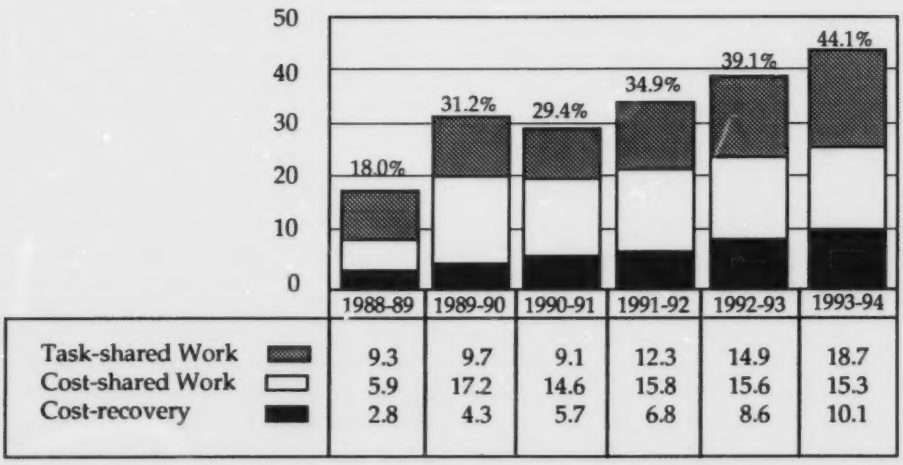
CANMET will pursue further benefit/cost analyses during the planning period. Moreover, CANMET is undergoing two major program evaluations that will address a series of efficiency and effectiveness issues. The results are expected in 1991-92.

Table 7.6
Client Contributions in Relation to CANMET Resources

Cost in $ millions

	1988-89	1989-90	1990-91	1991-92	1992-93	1993-94
Cost-recovery	2.1	4.7	6.3	8.0	10.0	12.0
Cost-shared Work	4.4	19.0	16.0	18.5	18.2	18.2
Task-shared Work	6.1	10.7	10.0	14.4	17.4	22.3
Total Client Contribution	12.6	34.4	32.3	40.9	45.6	52.5
Total Budget	75.4	110.2	109.8	117.2	116.7	119.0

Figure 7.7
Client Contributions: Percentage of Total CANMET Expenditures



December 1990

PART B

8 EFFICIENCY AND ALTERNATIVE ENERGY TECHNOLOGY BRANCH

Efficiency and Alternative Energy Technology Branch

Mission

Canada has much to gain by being efficient in energy consumption and by developing environmentally sustainable alternative energy supply technologies. These gains include decreased production costs, increased competitiveness, increased energy security and environmental improvements. With this in mind, the Efficiency and Alternative Energy Technology Branch (EAETB) mission statement is:

"...to strengthen the competitive position of the Canadian economy and support sustainable development through the development and commercial application of efficiency and alternative energy technologies for energy supply and demand."

Objectives

The EAETB strives to:

1. encourage reduced energy demand through increased efficiency;
2. develop alternatives to conventional energy sources and to increase their contribution to energy supply;
3. present solutions to environmental concerns through the use of efficiency and alternative energy technologies; and
4. improve the competitiveness of the Canadian economy.

Strategies

To meet these objectives, the Branch has adopted four strategies. Each will assist the Branch in overcoming financial, institutional and attitudinal barriers to the development and commercialization of efficiency and alternative energy technologies.

Encourage faster product and process development through R&D support
EAETB has a key role to play in expanding the scientific knowledge base through targeted funding of in-house and contracted-out R&D. Selected government support for R&D is critical for the fragmented, immature industries that are unable to fully support their own research activities.

Establish strategic partnerships
Strategic partnerships will be formed in key areas through joint funding, cost recovery and cost-shared arrangements, and personnel interchanges, with a wide range of organizations. This approach will maximize both technology transfer and the leveraging of federal funds.

Broaden awareness of efficiency and alternative energy technologies and their applications
The efficiency and alternative energy technologies being developed by EAETB and its partners offer solutions to environmental concerns. The Branch will strive to identify those areas of R&D with the greatest energy and environmental potential to allow the best allocation of resources. The Branch will work to raise awareness in Canada of the

opportunities offered by these technologies. This will be done by offering advice and information wherever it is required.

Establish CANMET as a recognized centre of expertise in efficiency and alternative energy technologies
Efficiency and alternative energy is a relatively new area of expertise within CANMET. For EAETB to achieve its objectives, it must first establish credibility in this area. With CANMET being recognized as a centre of expertise in efficiency and alternative energy technologies, EAETB will be well-placed to provide leadership to all sectors of the economy.

Activities

The principal source of funding for the Branch's activities is the Panel on Energy Research and Development (PERD), which is administered through the Office of Energy Research and Development (OERD).

The Branch will undertake a number of major activities to achieve its strategic priorities. EAETB will:

- **provide expert technical advice to government, the private sector, and the public;**
  The Branch will establish and maintain a scientific and technical knowledge base concerning efficiency and alternative energy.

- **plan, analyze and rank technology opportunities to help the Branch and industry target beneficial and marketable technologies;**
  We will conduct industry sectorial analyses to determine the extent of energy use, and apply technology assessments to technologies being considered for development. Once we identify useful and marketable technologies, the Branch will work with industry on a cost-shared basis for their development and commercialization.

- **plan, select and manage contracts and contribution agreements, with the assistance of the Research Program Office, on projects for the research and development of energy efficiency and alternative energy technologies;**

- **promote and participate in the development and implementation of national and international codes and standards;**
  This will promote a more efficient and cost-effective implementation of new technologies, and will help to ensure that standards of safety and quality are officially announced.

- **establish and maintain working relationships and partnerships with private sector companies, associations, academe and research organizations, other federal government departments, provincial governments and utilities; and international organizations:**
  This will encourage contact with industry and the public sector, information exchanges, collaboration on projects and participation on standards committees and other industry groups.

- **plan, manage and participate in information and technology transfer activities in collaboration with the Technology Marketing Division; and**

- **promote general awareness of CANMET and Branch activities.**
  This will include preparing promotional materials, making presentations to stakeholder groups, and writing articles for trade and technical journals.

Branch Organization

To carry out its mission, EAETB is organized into four divisions:

Alternative Energy Division (AED)
This Division develops renewable and alternative energy technologies, including biomass combustion and conversion, solar energy, wind energy, small and low-head hydro, alternative transportation fuels, and vehicle and engine efficiencies.

Energy Diversification Research Laboratory (EDRL)
The EDRL conducts R&D in alternative energy, with specific emphasis on renewable energy systems such as photovoltaics, the production of fuels and other hydrocarbon compounds from natural gas, and heat management technologies such as heat pumps.

Energy Efficiency Division (EED)
This Division develops technologies that increase the efficiency of energy use in both the industrial and building sectors. Activities included are the Industry Energy R&D (IERD) Program, the Building R&D Program, and the Passive Solar R&D Program.

Business and Technology Coordination Division (BTCD)
This Division provides a leadership, coordination, support and service role for the other three Divisions in such areas as planning, technology assessment, economic analysis, technology transfer and business development strategies. It also maintains technical and bibliographic databases, primarily in support of its planning and analysis, and information generation and dissemination roles.

Efficiency and Alternative Energy Technology Branch

Alternative Energy Division

Mission

In partnership with industry, utilities, provincial and federal government departments as well as other research institutions, the Alternative Energy Division (AED) conducts R&D to advance the development and commercialization of environmentally sustainable alternative energy supply technologies. These alternative energy technologies include: alternative transportation fuels such as propane, natural gas, hydrogen, methanol and ethanol; vehicle and engine efficiencies; direct combustion of biomass and biomass-derived fuels; conversion of biomass into alternative liquid, gaseous and solid fuels and chemicals; solar technologies; and small-scale hydraulic energy.

Alternative energy supply technologies can have a positive impact on the environment as their introduction on a large-scale will improve urban air quality, reduce global greenhouse gases, and reduce other forms of pollution resulting from conventional energy extraction, refinement and use.

Objectives

The AED strives to:

1. provide the science and technology needed for a diversified, economically sustainable energy economy;
2. investigate broad-scale environmental issues associated with these energy developments;
3. support the development and implementation of government policies related to alternative energy and the environment; and
4. promote the use of these technologies in the marketplace by assisting in information and technology transfer.

Structure of the R&D Program

The AED conducts its R&D through direct contracts and contributions to a broadly based client group working in the alternative energy area. Proposals for R&D work are generally made in response to requests for proposals that specify R&D priorities in the various alternative energy technologies. Committees comprised of technical experts from industry, government and universities establish these R&D priorities. These committees also provide key technical advice and direction for the management of the different technology areas. In certain instances, such as research into gaseous alternative transportation fuels, the industry associations are major contributors to the R&D program and act as program managers. The Division is also involved in collaborative projects funded and managed in partnership with utilities, provinces, and other organizations. Similarly, we are members of different international groups such as the International Energy Agency, wherein we jointly fund and cooperate on R&D projects of international interest. Allocations of funds to the various alternative energy technologies are made through the Panel on Energy R&D.

Approximately 60 percent of the R&D work sponsored by this Division is productivity-related in support of industry and research organizations; about 25 percent covers safety and consumer protection, while about 15 percent generates data to support policy development and implementation. Over 75 percent of the work is incremental research and development and the remaining 25 percent is strategic and exploratory in nature.

Organizational Structure

The Alternative Energy Division (AED) has 18 person-years (P-Ys) allocated for 1991-92 with an additional two person-years assigned from the Deputy Minister's Personnel Pool for the recruitment of young scientists. The current complement is comprised of 20 people: 16 professionals and 4 support staff.

In addition to the Director's office comprised of three person-years, the Division consists of three sections:

Transportation Energy:	6 P-Ys
Bioenergy Supply Technologies:	6 P-Ys
New Energy Supply Technologies:	5 P-Ys

Marketing Strategy

With so many different technologies, the AED serves a multitude of client groups and, in doing so, plays a leadership role in coordinating alternative energy R&D in Canada.

Major Clients

Users

The concepts of alternative sources of energy are still relatively unknown in many sectors. There is a major need to inform potential users, including utilities, industry and the public about the opportunities to be derived from the application of alternative energy sources; this is a major role of the Division.

Industry Associations

The various alternative energy industry groups are not typically well-funded or long-established organizations. They have a tradition of functioning as lobby groups to promote their technologies, but their efforts in this area are usually not as well-coordinated or executed compared with the more traditional energy industries. As a result, they require our support to function effectively. Other associations, such as the Canadian Gas Association (CGA), represent well-established companies and work closely with the AED. The CGA has realized the potential of natural gas as a transportation fuel, and has created a Natural Gas for Vehicle (NGV) group. This group consists of the gas utilities, the pipeline industries and the manufacturers of hardware associated with the end-use of natural gas in vehicles. The NGV industry is fragmented and therefore needs EMR to act as the catalyst, facilitator, and technical and financial supporter.

Research Community

For the most part, many of the alternative technologies are immature; considerable basic and applied research is still needed. Generally, the industries are not financially secure enough to be willing to make any substantial amount of funding available for R&D. As a consequence, a good proportion of R&D is conducted at universities and research organizations funded by the government.

Other Federal Departments

Because of the widespread interest in alternative technologies, AED staff work closely with other federal departments on cooperative R&D projects and promotion of these technologies. These partners include Environment Canada, Forestry Canada, Agriculture Canada, the National Research Council, Transport Canada, the Department of National Defence, the Canadian International Development Agency, Industry Science and Technology Canada, the National Science and Engineering Research Council and the Department of External Affairs.

Provinces

A number of provinces are active in the promotion and development of alternative energy technologies. These include Prince Edward Island, Nova Scotia, Québec, Ontario and Alberta. The Division coordinates efforts whenever possible.

International

The R&D work in Canada forms the basis for several international activities coordinated by the Division, the International Standards Organization, the International Energy Agency, and the International Electro-technical Commission. Further R&D activities are under way, involving bilateral arrangements with other countries in areas such as solar and wind power, bioenergy, and transportation.

Market Niches

There are a number of current market niches for alternative energy technologies, including:

- urban transit authorities that require natural gas and methanol buses in the near future and fuel cells and hybrid buses in the longer term;
- high-kilometre vehicles (such as taxis and light delivery vehicles) that run on natural gas, propane and electricity;
- densely populated urban centres that need low-emission vehicles and zero-emission vehicles;
- municipalities dealing with waste-management problems and landfill gas emissions;

- electric utilities that require peak-shaving and off-grid applications using renewable energy technologies;
- remote communities where fuel costs are high and the environment is particularly sensitive;
- large commercial buildings for preheating ventilation air with solar energy; and
- developing countries with indigenous renewable energy supplies as export markets.

Major Promotion and Communications Activities

A specific thrust in this area will be to work in conjunction with EAETB's Business and Technology Coordination Division in developing marketing strategies for various client groups working in alternative energy. In addition, several promotional and communications activities are under way or planned.

Co-sponsorships of major conferences, workshops and seminars include:

- the Windsor Workshop on Alternative Fuels;
- the Annual Conference of the Solar Energy Society of Canada Inc.; and
- the Institute for Gas Technology Conference on Energy From Biomass and Wastes.

The AED will participate in other conferences and workshops dealing with alternative energy technologies, including:

- the Canadian Pulp and Paper Association Annual Meeting; and
- the Demand-Side Management Conference.

Publications include:

- *Buyers Guide, PV (photovoltaic) Technologies;*
- *Biomass Information Technology Transfer System;*
- project reports;
- articles for journals, newspapers; and
- information brochures, factsheets, videos.

Strategic Thrusts, Plans and Outputs

R&D Strategic Thrusts for the Division

A major issue for the planning period is international, national and regional public and political support for the environment and sustainable economic development. This must be combined with concern that current energy-use patterns are detrimental, unsustainable and nonresilient. Concerns about global warming caused by CO_2 and other greenhouse gases, and atmospheric loading of acidic emissions, continue to grow. The net contribution of CO_2, SO_x and NO_x can be eliminated or considerably reduced through increased energy efficiency, and through substitution of alternative energy sources for fossil fuels. We anticipate that the federal strategy to address

environmental issues will involve some major initiatives to accelerate the development of alternative energy technologies. The Alternative Energy Division will be positioning itself to take on an expanded role.

In the transportation area, concern for urban air quality will provide opportunities for closer cooperation with the provinces and municipalities to accelerate the introduction of alternative fuels. Even a small substitution of natural gas for conventional fuels could generate approximately half a billion dollars of industrial activity by the mid-1990s, with attendant tax and other revenues to government. This shift in fuel use would also reduce pollution and develop worldwide interest in the associated Canadian technologies.

Regulatory measures being considered by other departments in the transportation and bioenergy areas may have significant detrimental implications for the penetration of alternative energy technologies into the market. Close monitoring and input into the development of these regulations will be required on the part of AED staff.

Concern about Canada's declining forest resources should encourage more intensive forest management and afforestation. That would give rise to a larger and more economically attractive base for forest products and bioenergy resources, and a more effective natural sink for CO_2. The Division will begin studies with Forestry Canada to define the magnitude of the opportunities in this regard.

National and regional priorities to alleviate environmental, health and safety hazards caused by wastes create opportunities for conversion of wastes to energy products while reducing these hazards. The AED will initiate discussions with provinces and municipalities to define opportunities and barriers to implementation.

The Division will pursue closer dialogue with utilities, regarding the development and introduction of alternative energy technologies to meet increasing electricity demand.

It will also encourage bilateral and other international involvement. Often other organizations, such as the International Energy Agency, have programs significantly larger than ours in the alternative energy field, and the Division is able to benefit from the information and experience gained through their efforts. The Division also supports activities in national and international standards to ensure the readiness of Canadian alternative energy products for both domestic and export markets.

The Division has almost completed strategic assessments of the various alternative energy technologies. These assessments are critical to the reallocation of resources to better meet the overall objectives of the Division and EMR in addressing environmental concerns.

R&D Plans and Outputs

Transportation Energy Program

In the petroleum fuels area, work on fuel demand and vehicle fuel economy will continue with the automobile, trucking and shipping industries. Research on emissions and fuel composition will continue in conjunction with the oil refiners and engine manufacturers to determine the impact of various sulphur levels on oxidation catalysts and particulate traps. AED-sponsored R&D will also focus on the selection, evaluation and demonstration of the durability and degradation of retrofit trap systems to reduce particulate emissions using existing diesel fuels in diesel engines of urban buses.

In the important area of biofuels R&D, the Division continues to develop lower-cost ethanol production technologies. Research is focussing on the increased productivity of hydrolysis processes and the development and commercialization of co-products from the conversion process. For thermochemical conversion, the AED will evaluate the technical and economic aspects of biomass feedstocks via vacuum, atmospheric, and high pressure pyrolysis processes. Prospects for their scale-up, product uses and commercialization potential will also be evaluated. In addition, the AED will focus on improved fractionation and isolation, and upgrading of bio-crude oils to industrial chemicals processes.

In the propane area, R&D will continue to be directed towards passenger and light vehicles.

The Division will conduct natural gas research in conjunction with the natural gas industry and the vehicle-conversion industry. This work will be directed towards both gasoline and diesel substitution and the development of an infrastructure to support the distribution of both fuel and conversions. Emphasis will shift to involvement by vehicle original equipment manufacturers to further encourage and develop the alternative transportation fuel market. Fundamental combustion research will provide a foundation for specialized natural gas systems, and decrease or eliminate the inefficiencies of conversion.

For alcohol fuels, an ethanol-fuelled bus project is under way to study the technical issues associated with ethanol in large engines. Work will continue in the design of methanol-fuelled engines for buses and trucks. Using technical demonstration funds under the Market Development Incentive Program, the Division plans to mount a ten-vehicle, "flexible-fuelled vehicles" technical demonstration.

The key areas of R&D in hydrogen and electrochemistry will be in energy storage, electrolytic production, safety, high-density batteries, and fuel cells. Efforts will be intensified to develop a methanol dissociation mechanism, to provide hydrogen from methanol as a means to more energy-dense, on-board fuel storage. Work will commence on a prototype fuel cell bus that initially will utilize gaseous

hydrogen, but eventually will incorporate methanol dissociation equipment.

Work is ongoing to review and improve safety and installation standards for natural gas-fuelled automobiles, and to develop and provide technical information services for natural gas for the automotive industry and researchers.

Anticipated outputs for this program are:

- in the area of hydrogen production, development work will be completed on an experimental bench-scale polymer membrane-separator for fuel cells (1991);
- a prototype methanol reformer compatible with a solid polymer fuel cell will be constructed by 1993;
- refinements on the prototype ten kilowatt-hour, LiAl/FeS battery module, aiming at a commercial prototype can be produced by 1993;
- reports on engine testing and emission characterization; cold start and sulphur tolerance; a trap oxidizer and oxidizer converter on emission control; and trap technology (for completion in 1991);
- development of technical data to provide to the Canadian General Standards Board for the preparation of national standards for automotive methanol fuel (ongoing);
- a prototype of a durable, reliable, compact and economical "natural gas for vehicle" compressor for small fleets and home use will be built in 1991;
- identification of the technical, economic and regulatory implications of methanol as a transportation fuel in large engines; development of operating procedures for methanol-fuelled fleets; characterization of methanol-fuelled vehicle emissions to enable the setting of emission standards for methanol fuelled buses; and technology transfer to the Canadian industry of methanol-based transportation systems will be completed in 1991;
- a technology report and development of a prototype for NO_x control from gaseous fuels will be completed by 1991;
- revised or new national standards for vehicle fuels for oxygenated gasoline, liquid petroleum gases, methanol, and natural gas (ongoing);
- the Waterloo Fast Pyrolysis process has been scaled up in Canada and Europe to a 5 ton/day capacity as a commercial demonstration, and is undergoing testing that will determine whether to proceed to the next scale-up stage (1991);
- the Rapid Thermal Pyrolysis reactor has been scaled-up to 100 kilograms per hour, and the technical and economic feasibility of producing specialty chemicals, polymers and fuel substitutes from lignocellulose is being investigated (1991);

- a process has been developed whereby conventional refinery technology can be used to convert plant oils to diesel octane enhancers (Engine tests are nearly completed and licensing negotiations are under way with a chemical company to develop this technology commercially in 1991);
- several major research studies are under way to reduce enzyme production costs and increase overall efficiencies of hydrolysis of lignocellulosic materials;
- an annual report on the progress of the Canadian Gas Association Natural Gas Vehicle R&D Program will be issued; and
- an annual report from the Propane Gas Association of Canada's R&D program will be issued.

Renewable Energy

The purpose of this program is to promote the research, development, and commercialization of new technologies utilizing renewable resources as energy supply systems or as substitutes for non-renewable fossil fuels. Federal involvement is necessary to carry the new industries working in this area from their current embryonic stage of development to a self-sustaining level of activity. The realization of this goal will result in the production and use of environmentally acceptable energy technologies, and the creation of new industrial development and employment opportunities, using Canadian renewable resources for the benefit of Canadians.

The following technologies are included in this area: bioenergy technologies such as combustion, gasification and fuel quality improvements; solar technologies; and small-scale, hydraulic energy.

In biomass combustion, research will continue into the development of highly automated wood-burning systems for the residential sector, utilizing wood chips or pellets. Support for a fully integrated biomass combustion test facility will be ongoing, and we expect that the private sector will eventually support this facility. The focus of this research will be on developing advanced combustion methods, such as pulverized firing and circulating fluidized bed combustion.

With regard to fuel quality, materials handling is a common requirement for all subsequent conversion processes. Work will continue on the development of a number of novel systems, including a bin and silo feeder, pneumatic conveying, and dewatering and moisture sensoring, leading to a more efficient and acceptable use of biofuels.

For the solar technologies, work will concentrate on the improvement of their cost-performance ratios so that they can more readily compete with traditional energy forms.

Expected outputs for this activity are:

- annual presentations of program results at national and international conferences and seminars;
- development, by 1991, of residential wood-burning systems that are generally 10-20 percent more energy efficient, while improving environmental performance by more than 500 percent (This work is closely coordinated with the activities at CANMET's Energy Research Laboratories);
- refinements to the bin and silo design and non-consolidating biomass feeder will be fully commercialized by 1991;
- a number of novel biomass materials-handling systems will be tested and optimized in industrial applications by 1991: pneumatic conveying, moisture sensor, dewatering and densification and grinding;
- critical assessments of several technology areas are nearing completion and will provide a much more directed, specific program (These assessments will serve as the foundation for the program's future activities, by 1992);
- current efforts in active solar R&D could result in a 25 percent reduction in the cost of solar domestic hot water systems by the end of 1993, due to improvements in controls, heat exchangers and the use of lighter, less expensive materials;
- a new type of Solarwall, using perforated aluminum, is expected to give a 40 percent improvement in the cost and performance of this air heating technology (Testing and performance monitoring of this product will be completed in 1991);
- new vertical-axis wind energy turbines in the 250-350 kilowatt capacity range are being tested for improved durability and will be completed in 1992;
- cooperative work with Hydro Québec, the Atlantic Wind Test Site and Environment Canada will provide valuable test data and information on the technical and economic feasibility of wind systems connected to diesel electric generators for remote applications (ongoing);
- work continues on photovoltaic-diesel hybrid systems operating in remote areas, leading to increased operating knowledge of system performance;
- cooperative work with Ontario Hydro will lead to a technical and economic assessment of the wide scale development of photovoltaic systems to reduce electrical peak loads (1991); and
- current work in small hydro R&D will lead to the development of improved manufacturing and design aids, and site-development computer programs. A cooperative effort with the Canadian Electrical Association will produce a design guide for an innovative low-hydro system for remote sites (1991).

Efficiency and Alternative Energy Technology Branch

Alternative Energy Division

Management and Administration

Integration of this Division into the existing CANMET Management Information System and the Government Financial System will continue in cooperation with CANMET's Research Programs Office and EMR's Finance Department. These systems will be modified to improve their utility in meeting the needs of the Division.

To improve staff motivation and skills, the Division will encourage staff to take additional training and to participate in special assignments and secondments. More tasks will be delegated to foster professional and career development.

Resources

Table 8.1
Resource Allocations of the Alternative Energy Division by Category of Expenditures

Financial Resources ($000)	planned	actual		
	1989-90	1989-90	1990-91	1991-94
Salary	1,552.0	1,785.0	1,103.0	955.0
Operating	465.0	465.0	706.0	700.0
Contract	10,968.0	10,349.0	8,264.0	8,362.0
Contributions	1,784.0	2,046.0	1,749.0	1,581.0
Total	**14,769.0**	**14,645.0**	**11,822.0**	**11,598.0**

Person-year Resources	planned	actual		
	1989-90	1989-90	1990-91	1991-94
Person-years	28	23	22	18

a 1989-90 figures from the FAMIS Report b 1990-91 figures from the Multi-year Operational Plan

Performance Monitoring

The Division continues to fund all of its R&D work through contracts, much of it on a cost-shared basis. Our target is to maintain a 55 : 45, EMR : client cost-shared ratio in the 1991-94 planning period.

In terms of developing human resources, the target is to have two staff members working outside the Division on secondment or assignment and two individuals working with us from outside the Division.

With respect to technology transfer, the Division expects to sponsor or co-sponsor up to five national and international conferences, workshops and seminars involving over 1,500 person-days attendance. In addition, the Division will negotiate at least two royalty-bearing licensing agreements for technologies developed with CANMET funding.

Mission and Objectives

The mission of the Energy Diversification Research Laboratory (EDRL) is to conduct applied research in the fields of renewable energy and energy efficiency in cooperation with industry.

CANMET's primary objective is to accelerate the adoption of techniques for using forms of renewable energy and, with the other CANMET laboratories, to promote energy efficiency in all sectors of Canada's economy.

Composition of the R&D Program

EDRL's research programs can be grouped according to CANMET's objectives of enhancing the competitiveness of the Canadian economy, protecting the environment and health, and supporting government policies. These groupings are somewhat arbitrary, since some kinds of research increase productivity while improving environmental protection. Energy efficiency measures are a case in point.

EDRL's research will cover three areas: renewable energy and hybrid systems (photovoltaics), energy management techniques (heat pumps, storage and transmission) and the use of natural gas (storage and conversion). About 60 per cent of EDRL research concerns environmental protection, while 30 per cent relates to productivity.

The research programs are also divided into four categories: strategic (research projects which form and nourish CANMET's technology base), complementary, services (short-term projects for a specific client) and exploratory (basic research).

Above all, EDRL research will be strategic, since 65 per cent of its mandate concerns long-term needs. Approximately 25 per cent of the research will concern short-term development and services. Ten per cent of our research will be exploratory in nature.

Complementary **20%**	**Strategic** **65%**
Services **5%**	**Exploratory** **10%**

Organization Structure

EDRL's organizational structure has two parts. The first comprises the three research fields, while the second includes the administrative section, technology transfer and business development.

Marketing Strategy

Clients

In the short term, forms of renewable energy are feasible in the remote regions. Marketing them requires the participation of several groups, including the public electrical utilities, energy suppliers, the territorial and provincial governments, various federal government departments and systems manufacturers. These groups will act as consultants, take part in the planning of the research programs and help implement concrete projects. In the long term, development of these technologies will require coordination of research with the universities and the private sector.

One goal of the renewable energy R&D program is the development and demonstration of systems for off-grid applications, especially in northern areas where conventional fuels are very expensive and present an environmental problem. Research niches will involve systems engineering, development of safety and performance standards, improvement in the performance of these systems and demonstration of their reliability.

The energy management research program will include energy storage, advanced heat transfer techniques, development of heat pumps, refrigeration systems and advanced energy management systems.

Target clienteles in the energy management field are industrial and commercial users and manufacturers involved with heat pumps, heat exchangers, heat convectors, cogeneration, refrigeration and air conditioning.

Finally, the research program concerning the use of natural gas will focus on the direct use of natural gas in vehicles, the conversion of natural gas to liquid fuel and the conversion of natural gas by non-catalytic methods, such as activation of natural gas by radiation, plasma or electrochemical means.

Clients include those involved in the use and conversion of fuel resources, the energy industry and gas companies, as well as equipment manufacturers, the provincial governments and certain federal departments.

Promotion and Communication Activities

One role of EDRL will be to disseminate information generated by its research. To accomplish this, EDRL will use normally available approaches, such as publications, conference participation, demonstration projects and publication of performance and safety standards.

EDRL is also assuming national responsibility for the technology transfer program at the Centre for Analysis and Dissemination of Demonstrated Energy Technology (CADDET), the technology transfer arm of the International Energy Agency (IEA).

Strategic Thrusts, Plans and Outputs

Research Program in Energy Management

CANMET has been involved for several years now in the development of energy management techniques. The EDRL research program in energy management will include energy storage, advanced heat transfer technology, development of heat pumps, refrigeration systems and advanced energy management systems.

There are a great many industrial applications in which sources of low-grade heat, such as cooling water or excess steam, are discarded into the environment. EDRL will work to develop technologies for the recovery and use of this heat, particularly for air conditioning and refrigeration purposes. These technologies will grow in popularity as CFCs are eliminated. EDRL will act as a focal point for this research in Canada and abroad.

Advanced heat transfer technologies also have enormous potential for saving energy. Conventional heat exchangers are very expensive and not very efficient. EDRL will concentrate on the development of direct-contact exchangers and heat convectors. These technologies could have a major impact on the efficiency of heat pumps, cogeneration and many other applications. Finally, EDRL will be working on the development of short- and long-term heat storage technologies.

Objectives and Work Plan

The objectives of the energy management research program are to:

- establish the infrastructure and necessary expertise to stimulate the development of techniques for the recovery, transfer and storage of energy;
- provide leadership in the field of recovery techniques and coordinate the research nationally;
- contribute to the development of technologies for using recovered energy in air conditioning and refrigeration;
- contribute to the development of technologies for the short-term and seasonal storage of energy; and
- contribute to the development of cleaner, more efficient energy transfer technologies.

Planned Activities

EDRL plans to:

- establish a research group specializing in energy management technologies (in progress);

- initiate a consultation program to familiarize the staff of the research group with the various parties involved in this field, and to R&D priorities more precisely (1991-92);
- prepare a report on progress in technologies considered advantageous, and recommendations of general research directions and priorities (1991-92);
- prepare an initial research plan (1991-92);
- establish the necessary infrastructure for energy management research (1991-95); and
- initiate and coordinate a research program in the use of unconventional energy sources for air conditioning and refrigeration (1992-95).

Contract Reports

EDRL will produce reports on:

- the evaluation and optimization of energy storage in batteries with l'Institut de recherche d'Hydro Québec (IREQ) in 1991; and
- the storage of energy in chemical heat pumps in 1992.

Renewable Energy Sources and Hybrid Systems

Renewable energy sources are considered the energy of the future because they are both inexhaustible and ecologically sound. However, much research and development work remains to be done before these energy forms are a viable option. EDRL is therefore proposing that it initiate a research program in this field.

The renewable energy research will concentrate primarily on photovoltaics (PV). This field has been chosen because of its short- and long-term marketing possibilities, its energy potential and the type of energy it provides.

Photovoltaics produces electricity, with all the flexibility associated with this energy form in terms of the use of existing infrastructures, ease of transmission, ease of integration and so on.

Photovoltaics offers short- and long-term marketing possibilities. In fact, it is already cost-effective in remote regions where energy costs are very high. For this technology to penetrate that market, however, its reliability must be demonstrated.

In the long term, experts predict, there will be a substantial decrease in the cost of electricity produced by PV, which means that this technology will compete with conventional energy sources for various applications in urban environments. Considering the energy potential offered by PV and its possible use without any geographical limitations, this technology will be an important energy source throughout Canada in the future.

There are several barriers to the penetration of PV into the energy markets. However, these barriers can be eliminated by:

- demonstrating the reliability of PV systems to users and buyers of these technologies;
- improving the performance of the systems (reliability, efficiency and cost);
- developing safety and performance standards; and
- developing new techniques for using PV.

These barriers are the subject of EDRL's research program.

Objectives and Work Plan

The objectives of the renewable energy research program are to:

- establish the infrastructures necessary to develop, test and certify PV systems;
- carry out research and development on PV systems and components in cooperation with the private sector;
- evaluate and develop PV systems for various applications;
- carry out demonstration projects in remote regions;
- act as liaison between the international community and Canadians involved in PV;
- develop safety and performance standards for these systems; and
- study the integration of PV into a grid.

Planned Activities

In the field of renewable energy sources and hybrid systems, EDRL plans to:

- manage the Department's PV research program (in progress);
- establish a PV research group (1992);
- initiate a research program in such areas as refrigeration and lighting (1992-93);
- develop a research program on hybrid systems (1992-93);
- inititate a program to develop performance and safety standards for PV systems and components (1993-94);
- begin a demonstration program for hybrid systems in northern regions (1994-95); and
- complete installations for implementing an advanced photovoltaics research (1994-95).

Research Program in the Use of Natural Gas

Natural gas is a clean fuel which is largely under-utilized because of problems associated with moving and storing it. This is particularly evident in the transportation field. EDRL will therefore examine the possibility of setting up a research program, in cooperation with the gas distributors, to promote greater use of natural gas.

Vehicles Using Natural Gas

There are two approaches to the use of natural gas in the transportation sector. The first involves the direct use of natural gas in vehicles. This concerns the necessary infrastructures to fuel vehicles, storage in vehicles, combustion in engines and control of emissions. The second concerns the conversion of natural gas to a liquid fuel, allowing the use of all the infrastructures already in place.

EDRL is examining the possibility of starting a research program on the storage of natural gas and the control of emissions in vehicles using natural gas. This project will be submitted soon to the gas industry for their recommendations regarding the directions EDRL's work should take.

Conversion of Natural Gas

For a number of years, CANMET's Energy Research Laboratories (ERL) Division has assumed the leading role in stimulating research on the conversion of natural gas. The Division's efforts concentrated on catalytic methods. However, there are very promising non-catalytic approaches, such as the activation of natural gas by radiation, plasma or electrochemical means. EDRL is therefore planning to launch a research program in this field.

The first phase will consist of an evaluation of the most promising technologies. Activation of natural gas by plasma offers several advantages for the conversion of natural gas to high-value-added products. Gaz de France has developed a unique plasma which allows the direct hydrogenation of hydrocarbons using natural gas. EDRL is studying the possibility of continuing these developments.

Another technology with interesting potential is the conversion of natural gas to alcohols using a microwave reactor. This technology, developed on a laboratory scale at Queen's University, is unique since there is no technology for converting natural gas directly into liquid hydrocarbon. A research program is required for a realistic evaluation of this technology.

Objectives and Work Plan

The objectives of the research program on the use of natural gas are to:

- initiate one or two joint projects with industry in the field of natural gas use;
- establish the infrastructure and necessary expertise for a flexible research program in techniques for using natural gas; and
- initiate specific research projects in cooperation with industry.

Planned Activities

EDRL plans to:

- establish a research group specializing in the technologies of natural gas applications (1991-95);
- initiate a consultation program to familiarize the staff of this research group with the various parties involved in this field, and to define R&D priorities more precisely (1991-92);
- prepare a report on progress in technologies considered advantageous, and recommend general research directions and priorities (1991-92);
- prepare an initial research plan (1991-92); and
- establish the necessary infrastructure for research (1991-95).

Administration and Information Transfer

Objectives

The objectives of the administration are to:

- establish the necessary infrastructure for the administrative management of the laboratory;
- initiate and coordinate a plan of activities to set up the laboratory;
- integrate the new laboratory into CANMET; and
- establish and manage the IEA (CADDET) program.

Planned Activities

In this area, EDRL plans to:

- coordinate the construction of the new laboratory (1991-93);
- develop a system for managing finances (1991-92);
- implement the staff recruitment plan (1991-92);
- determine the clientele and target markets for the research niches and the CADDET program (1991-93);
- develop written documentation concerning the laboratory, the research niches, the services offered and the CADDET program in Canada (1991-93);
- plan events related to the various construction phases, inaugurate the new laboratory and research agreements with other institutions and private companies (1991-95);
- organize conferences, symposiums, seminars and specialized workshops, at least once per year, (1991-95);
- participate in conferences and exhibitions (1991-95); and
- develop tools to accelerate promotion of EDRL in cooperation with the Technology Marketing Division and EMR Communications (1991-93).

Resources

Table 8.2
Resource Allocations for the Energy Diversification Research Laboratory by Category of Expenditure

Financial Resources (in $000)

	1990-91	1991-92	1992-93	1993-94
Salaries	1,042.9	1,547.0	1,629.7	1,719.1
Operating Funds	876.0	950.0	950.0	950.0
Equipment	1,000.0	1,500.0	1,950.0	750.0
Capital Expenditure [b]	—	3,000.0	4,350.0	750.0
Contract Funds [c]	1,045.0	1,504.0	1,365.0	1,256.0
Total	3,963.9	5,501.0	5,894.7	4,675.1

Person-year Resources

	1990-91	1991-92	1992-93	1993-94
Person-years	17	25	25	25

a The forecast amounts in this table may be modified as a consequence of the orientation of policies in Environment Canada's *Green Plan*.
b The funds for capital expenditure are still being negotiated within EMR.
c These figures include $600,000 of PERD funding for research in photovoltaics which was recently transferred from the Alternative Energy Division to EDRL.

Mission

The Energy Efficiency Division (EED) aims to foster and support the development and use of technologies that contribute to more efficient use of energy in the industrial, commercial and building sectors.

In partnership with industry, utilities and other jurisdictions, the Division's mission is to sponsor mostly cost-shared R&D and technology transfer in order to accomplish the following objectives.

Objectives

The EED strives to:

1. attain efficient and sustainable use of Canada's energy resources;
2. contribute to environmental quality;
3. enhance the productivity and competitiveness of the Canadian economy; and
4. support government policy initiatives.

Structure of the R&D Program

The R&D program in energy efficiency has two major components: buildings and industry. Each component addresses both protection and productivity objectives. Increases in energy efficiency also reduce the environmental impacts and, provided these measures are cost-effective, increase productivity as well.

On the buildings side, although the program has addressed the residential sector in the past, the Division is now switching its emphasis to include commercial and institutional buildings. The work concentrates at least as much on technology transfer and the development of a technical infrastructure (testing, standards and training) as on technology development. The program is seen as strategic with a variety of elements that combine to form a comprehensive program. As for industry, the program has been largely reactive, serving the productivity needs of industry while yielding environmental and energy benefits. This activity will evolve toward a more strategically directed one, with more emphasis on replicability and greater environmental benefits.

Marketing Strategy

Buildings

Clients

- building industry associations: Canadian Home Builders Association and its regional offices; Building Operators and Managers Association; the Canadian Window and Door Manufacturers Association; and Energy Management Task Forces;
- manufacturers of energy-efficient building components (windows, appliances, furnaces, water heaters, insulation);
- utilities (gas, oil and electric);

- provincial ministries of energy and housing;
- research groups (provincial research organizations, testing laboratories and universities);
- standards-writing bodies (Canadian Standards Association, Canadian General Standards Board, International Standards Organization);
- energy policy sector and other government departments (especially the National Research Council and Environment Canada); and
- international organizations (the International Energy Agency, the Organization for Economic Cooperation and Development).

Industry

- Pulp and Paper Research Institute (PAPRICAN), Pointe Claire, Québec;
- Powerplex Technologies Inc., Toronto;
- Stackpole Limited, Mississauga, Ontario;
- Cassiar Mining Corp, Cassiar, British Columbia;
- Alcan International, Montréal;
- Guertin Brothers, Coatings and Sealants, Winnipeg;
- Cogeneration Associates Ltd., Toronto
- GE Canada Limited, Peterborough, Ontario;
- ESSO Petroleum Canada, Sarnia, Ontario;
- Canadian Electrical Association; and
- the Mining Association of Canada.

Market Niches

Buildings

- R-2000 technology;
- high-performance windows;
- integrated heating, ventilating, cooling;
- efficient lighting and daylighting;
- building design tools;
- energy management systems; and
- expert systems.

Industry

- water-based automotive paint;
- powder metallurgy auto parts;
- water removal and drying;
- high-efficiency electric motors;
- lube oil for low-heat injection engines;
- cogeneration;
- asbestos processing;
- sodium sulphur batteries ; and
- ceramic cutting tools.

Promotion and Communications Activities

- sponsorship of workshops to document state-of-the-art advances in lighting, windows and integrated mechanical systems (two per year);
- sponsorship of world conference on R-2000 homes (1991);
- sponsorship of seminars on industry energy-efficiency success stories (1991 and 1993);
- co-sponsorship of the International Energy Agency's Air-Infiltration and Ventilation Centre Annual Conference (1991);
- development and distribution of promotional and informative brochures on building and the Industrial Energy Conservation R&D Program;
- development of display materials for use at seminars and workshops;
- distributing press releases and other promotional material announcing the approval of major agreements and contracts;
- cross-Canada meetings and seminars to tell key clients and potential partners about the activities of the buildings and industry groups; and
- presentations and attendance at a range of technical committees, workshops and conferences sponsored by industry associations, utilities, other jurisdictions and standards organizations.

Strategic Thrusts, Plans and Outputs

A heightened awareness of the environmental consequences of energy use has forced greenhouse gas emissions almost to the top of the energy agenda. Energy efficiency is the key to addressing global warming in the foreseeable future. Of the reduction in CO_2 emissions projected to 2005, fully 75 percent is expected to be derived from energy-efficiency improvements.

Strategic Thrusts

A number of new initiatives have been proposed to respond to this priority. Each of these initiatives can be addressed only to a very limited degree within existing resources, and only at significant cost to ongoing programs. Reallocation of resources within the Division has already taken place. The second stage of resource adjustment is to seek reallocation within the program of the Panel on Energy R&D (PERD). New proposals have been submitted that will require substantial shifts in existing PERD funding patterns. Most importantly, initiatives are also being tabled as part of *The Green Plan*. If successful, these routes would provide incremental funding for both R&D and field trials, and additional staff to manage these programs.

Regardless of the success of requests for additional resources, the programs in buildings and industry will be refocussed to address reduction of greenhouse gas emissions. This will be the dominant criterion for project selection. This suggests that programs will be sensitive to the source of energy being saved (i.e. fossil-fuel derived energy).

Indoor air quality is another significant environmental problem that is often associated with increased building-energy efficiency. The "sick building syndrome" is a real problem; the Division will address air quality as a critical parameter when developing integrated building energy systems and controls.

Buildings represent approximately 34 percent of energy end-use in Canada. The Division's activities have focussed on residential buildings, including the development of the technical basis for the R-2000 Home Program. This has shown that the building industry can build energy-efficient houses that result in up to 50 percent energy savings, for space and water heating when compared with houses built according to the Building Code. The Division's current funding allows for R&D and technology transfer initiatives for individual technologies, particularly high-performance windows, daylighting and integrated mechanical systems.

Beginning in 1990, the Division will shift its emphasis to include large-scale buildings that, in most cases, have high energy consumption, high impact on peak loads and limited adoption of new technologies. The new initiative will aim to extend the R-2000 concept to provide the mechanism and the infrastructure needed for rapid adoption and integration of technically-sound, cost-effective, reliable and safe energy-efficient building technologies, products, equipment and services. This will be achieved by developing the standards, codes and quality-assurance procedures needed to commercialize promising energy-efficiency technologies, and by developing and assessing new technology products. The Division's goal is to achieve a 50 percent energy-efficiency improvement over current average energy intensity in new buildings, and a 25 percent reduction in renovated buildings.

The industrial sector accounts for about 35 percent of energy end-use in Canada, and this share is increasing. The current activity, the Industry Energy Research and Development Program, is primarily reactive, supporting the development of more energy-efficient products and processes in response to proposals from the private sector. This approach has been very successful, returning energy savings, environmental benefits and economic development that are very large compared with the government's investment in the program.

The Industrial Energy Conservation R&D Program (IERD) will be complemented by a more proactive program that will target key energy-consuming industries and operations. Sector studies will identify opportunities and needs within the mineral industry, for instance. These studies will be coupled with technology assessments that will match needs with emerging technology to improve energy efficiency in the target industry/operation. Establishing productivity and environmental criteria will be an integral part of project selection, and will be conducted in close cooperation with the target industry.

The Division will pursue national and international collaboration through partnerships with private sector associations, provinces, utilities, standards writing organizations, universities, engineering firms and manufacturers. The program will seek co-funding for most activities and will be implemented primarily through cooperative agreements.

R&D Plans and Outputs

Buildings

Passive Solar

This contracted-out program includes the cost-shared development of high-performance windows, advanced fenestration technology, daylighting, solar energy storage, and passive-solar design tools.

Specific outputs include:

- a draft Canadian Standards Association standard for evaluating window performance (1991);
- updated versions of "FRAME" and "VISION" window analysis projects (1991);
- a long-term performance study of windows subjected to pressure and motion cycling (1992);
- a report on monitored versus simulated performance of advanced houses (1992);
- new convective-flow barriers in windows ready for commercialization (1993);
- prototype of an all-solid-state electrochromic window (1993);
- guidelines for use of daylighting design tools (1993); and
- study of the design of advanced house construction and monitoring of a commercial building employing advanced passive-solar concepts (1994).

Residential and Commercial

This program is also contracted out and includes building envelopes, indoor air quality, energy systems and components, appliances, equipment, design tools and controls.

The program includes:

- monitoring and reporting of the performance of Whitehouse Senior Citizen's R-2000 multi-unit building (1991);
- standards for ventilation and ventilation equipment (1992);
- a database on performance of innovative buildings (1993);
- standards on ground-source heat pumps (1991-93);

- updated HOT 2000 Energy Analysis Program (1991-93);
- field trials of new lighting systems for large buildings (1992); and
- field trials of new building controls.

Industry

The Industry Energy R&D (IERD) Program

The IERD Program will continue to carry 15-25 projects at any one time and five to ten new projects will be added each year. Each new project will have an ad hoc group of technical experts (from various government departments and agencies) to review and advise on submitted project proposals. If their findings warrant it, an IERD project submission will be prepared by the Secretariat to the IERD Board.

A consortium approach will be encouraged for all projects. Thus each project is expected to feature an agreement between a technology developer, a supplier, a technology delivery agent (manufacturing or engineering company) and a user. In all cases, exploitation of the technology for the benefit of Canada will be a prerequisite for support.

Over the next four years, the Division plans to complete the following projects, with commercialization in mind:

- two different but complementary technologies for drying newsprint (1992 and 1994);
- new lubricants for low-heat rejection engines (1992);
- recycling technology for diesel lube oils (1991);
- a sodium sulphur battery for electric vehicles (1994);
- new automotive paints (1992);
- new industrial paints (1992); and
- two applications of microwave energy to sintering of ceramic components (1992 and 1993).

Class 34 Program

The Energy Efficiency Division provides the technical expertise to certify that certain capital costs associated with systems for heat recovery, cogeneration, and alternative energy installations meet the eligibility criteria set out by Revenue Canada for Class 34. Where criteria are met, an accelerated three-year write-off of such costs is allowed. Annual specific outputs include:

- 40-50 certificates of eligibility;
- 30-40 prior opinions on potential projects; and
- three on-site audit reports.

Proactive Industrial R&D Program

The Division will develop a new proactive program to focus projects in key energy-consuming industries. These initiatives will rely on very close cooperation with industry associations and will attempt to match industry needs with technology opportunities. Industry sectors will be characterized from the point of view of energy utilization, technology trends and investment climate. Under this Program, the Division will examine new and emerging generic technologies to determine their applicability to specific industry sectors.

Sector Studies

Mineral Industry	
mining	1991
processing	1992
Pulp and Paper	
kraft mills	1991
refiner pulp mills	1992
Cement Industry	1993

Technology Assessments

recycling paper	1991
recycling aluminum	1991
bleaching of wood pulp	1992
condensing heat recovery from flue gases	1992
low NO_x burners	1993
microwave drying	1994
turbo expanders	1994

Management and Administration Issues

By the end of 1991, the EED will be fully linked into the CANMET Management Information System through the acquisition of the required hardware and software, and the conversion of divisional procedures to match the needs of the CANMET system. The existing Macintosh network within the Energy Efficiency Division will remain and will constitute the workstations for interfacing with the CANMET network. Interfaces with the EMR's Government Financial System will be established by 1991.

Because of the many reorganizations and extensive downsizing that the energy efficiency activity faced before joining CANMET, staff morale has suffered. We will hold frequent meetings (every two weeks) of all staff to ensure that everyone is informed of and can respond to management expectations, group interests, project status, staff issues

and strategic plans of the Division. Also, we will foster a strong team environment with a participative management style. Finally, we will stress the importance of the role of the Division in meeting the challenge and opportunities of increasing energy efficiency. The EED will acknowledge performance in front of the group at every opportunity.

We intend to pay more attention to training, and will encourage greater use of training opportunities. This will be dealt with explicitly during year-end appraisals and mid-year performance reviews. All staff will be encouraged to identify their own professional development opportunities. Special assignments and secondments are part of this initiative.

Should new personnel resources be allocated, staffing will emphasize the need to increase representation of under-represented groups, consistent with the requirement to have competent, well-trained, and highly motivated staff.

The EED will foster staff development through more rigorous and demanding objective-setting and review as part of the twice-yearly performance reviews. Greater delegation, not only of tasks but also of responsibility and authority, will be expected.

Team reviews of projects will take place each quarter. These reviews will be open to all staff.

All projects will be subjected to an Environmental Assessment Review Process (EARP) to determine and address any negative environmental impacts. Projects supported by the Industry Energy R&D Program

Resources

Table 8.3
Estimated Resource Allocations of the Energy Efficiency Division

Financial Resources ($000)	1990-91	1991-92	1992-93	1993-94
Salary	972.0	941.0	988.0	1,035.0
Operating	354.0	359.0	359.0	359.0
Contracts	1,284.0	1,681.0	1,726.0	1,712.0
Contributions	5,208.0	4,865.0	4,853.0	4,840.0
Capital	8.0	35.0	35.0	35.0
Total	**7,826.0**	**7,881.0**	**7,961.0**	**7,981.0**

Person-year Resources	1990-91	1991-92	1992-93	1993-94
Person-years	17	15	15	15

have the greatest potential for environmental impact because they are large and industry-oriented. Implementation of a formal EARP should be relatively simple since environmental reviews have always formed an integral part of project approvals.

The interdisciplinary nature of energy efficiency technology will require that the Energy Efficiency Division rely on scientific support and advice from a number of other CANMET Divisions, especially ERL. Also, the need to ensure that the benefits of energy efficiency technology are as widely understood as possible calls for substantial support from the Technology Marketing Division and the Business and Technology Coordination Division.

Performance Monitoring

Table 8.4
Resource Distribution by Program

	1990-91	1991-92	1992-93	1993-94
Industry Programs	5,984.0	5,638.0	5,644.0	5,650.0
Building Programs	1,842.0	2,098.0	2,165.0	2,173.0
Divisional Management and Support	0	145.0	152.0	158.0
Total	7,826.0	7,881.0	7,961.0	7,981.0

Table 8.5
Key Performance Indicators of the Energy Efficiency Division

	planned	projected		
	1990-91	1991-92	1992-93	1993-94
Percentage of Cost-shared Work (contracts)	34.4	37.5	37.5	37.5
Secondments				
to EED	0	2	0	0
from EED	0	0	0	0

Efficiency and Alternative Energy Technology Branch

Business and Technology Coordination Division

Mission

The Business and Technology Coordination Division (BTCD) plays a coordinating, support and service role for the three other Divisions within EAETB in the areas of information transfer, marketing, analysis, technology transfer and business development. Working with the EAETB's Technology Marketing Division and other groups within CANMET, the Division acts as a key interface between the Branch and other agencies.The mission statement of the Division is:

"...to support and coordinate Branch activities by developing and implementing information, marketing and business development strategies; and planning and analysis procedures."

Objectives

BTCD's goals are to:

1. encourage the use of efficiency and alternative energy technologies by promoting awareness of the Branch, its activities and technologies;
2. market the services and expertise of the Branch;
3. encourage the movement of appropriate EAETB technologies and practices into the marketplace by developing business opportunities; and
4. assist the planning process by providing technology assessments and analytical services to the Branch.

Organization

The BTCD is organized to cover marketing through technical information, business development, planning, and coordination activities. Currently, there is a total person-year complement of 12; this will decrease to 10 in 1991-92 and subsequent years. With this downsizing, a review of the organizational structure is underway.

Marketing Strategy

Key clients of the Branch are the scientific community, the energy and technology supply industries, government organizations, all energy users and a variety of international clients.

Major Clients

Because of its support and coordination role, the Business and Technology Coordination Division's major clients are senior management; the three technology Divisions of the Branch; other groups within EMR (Office of Energy R&D, EAETB, and so on); CANMET (specifically the Technology Marketing Division, the Research Program Office, and the Energy Research Laboratories); advisory groups to CANMET; and other government departments and agencies (such as Environment Canada and the National Research Council).

Major Marketing and Communication Activities

The Division's promotion and communication activities cover the collection, synthesis, production and publishing of material, and the dissemination of this material to targeted audiences. These activities are carried out in close cooperation with other Divisions, CANMET's

Technology Marketing Division, Energy, Mines and Resources' Communications Department, and other government and non-government agencies.

The Division also responds to enquiries from the public, trade organizations, industry, academe, and others concerning the activities of the Branch, its technologies and practices.

The BTCD works closely with other EAETB Divisions in:

- strengthening and promoting energy-efficient and environmentally beneficial technologies through information packages, demonstrations and workshops;
- identifying target markets and clients for information and business development;
- ensuring that Canada's environmentally beneficial technologies are promoted in the international arena (through the International Energy Agency's Centre for the Analysis and Dissemination of Demonstrated Energy Technologies Program, CADDET);
- assessing technologies for their market and technology potential, and for their energy and environmental impact;
- coordinating EAETB's input into departmental energy and environmental policy initiatives;
- coordinating EAETB's activities with other federal and provincial departments, agencies and government bodies; and
- organizing outreach activities such as workshops, conferences and seminars.

Strategic Thrusts, Plans and Outputs

The BTCD plays an active coordination and leadership role for other EAETB Divisions to ensure that CANMET's and the Branch's strategic thrusts are realized. The Division's strategic thrusts can be summarized under three headings:

- marketing of Branch technologies and programs;
- technology assessments in support of Branch marketing and business development opportunities; and
- raising Branch profile and coordinating client-related activities.

General Links to Strategic Thrusts

The BTCD promotes Branch activities and technologies by writing and publishing a wide variety of material on individual technologies and practices.

Publications

- articles for newspapers, periodicals, trade and technical journals that have wide circulations reaching

professionals in all sectors including industrial, commercial, institutional and residential energy users;

- articles written in cooperation, on a cost-shared basis, with various journals and magazines;
- brochures and popular-style booklets prepared for energy users;
- specific technology digests and fact sheets aimed at energy suppliers, technology industries and governments; and
- information packages designed for, and provided to, specialist groups such as: consultants and contractors; research institutions; universities; and international organizations.

Seminars, Demonstrations and Workshops

Promotional material is developed for presentations at seminars, workshops, conferences and departmental meetings. For example, at least six seminars are scheduled for each year, to be held in specific regions and for target audiences covering EAETB's key technologies.

Networking

The Efficiency and Alternative Energy Technology Branch uses existing federal and provincial government networks and databases to help disseminate its information. These include networks of the National Research Council, the Industry, Science and Technology Centre, the Canada Mortgage and Housing Corporation and provincial energy departments.

International Arena

The Energy Diversification Research Laboratory represents Canada on the International Energy Agency's Centre for the Analysis and Dissemination of Demonstrated Energy Technologies (CADDET) Program. This Program provides a forum for member countries to transfer information on new and promising energy technologies between countries, thus promoting the use of these technologies. The BTCD develops materials for the CADDET Program.

Technology Information System (BITTS and DIS)

These systems contain information on EAETB's bioenergy technologies and projects. Two components of the system have been developed, the Bioenergy and Information Technology Transfer System (BITTS) and the Documentation Inventory System (DIS). The Technology Information System is being expanded to embrace all energy technologies. It has a range of analytical capabilities, including desktop publishing for individual factsheets.

Together with Newfoundland's provincial government, the BTCD is collecting information on bioenergy projects for eastern Canada; efforts are being made to encourage other departments and countries to cooperate on this project (such as Environment Canada, the United States Department of Energy and the International Energy Agency).

Major Plans and Outputs

In its coordination role, the Division is directly responsible for a number of outputs that promote the activities of the Branch and help to develop a corporate CANMET/EAETB image. They include: EAETB's business plan; and branch and divisional strategic plans in cooperation with the Research Program Office, and EAETB's Divisions.

Approximately 40 R&D reports are published each year. They appear as scientific reports or synopses in trade journals and other professional magazines. The Division prepares articles for various international newsletters (such as *Liaison Énergie-Francophonie*, with more than 4,000 international readers) and will contribute material to an environmental supplement that will reach more than one million consumers.

In conjunction with CANMET's Technology Marketing Division, the BTCD produces brochures and factsheets on the Branch and its programs (such as the Industry Energy Research and Development Program series scheduled for production during 1991-92, and updates of the *R&D Project Digest* series).

The Division will continue to respond to enquiries concerning the Branch's activities. Questions come from within Energy, Mines and Resources, other government departments, academe, the private sector and the public. The Division responds to more than 1,600 enquiries annually.

The BTCD recognizes the need to share costs with other parties and so it, together with other Divisions in the Branch, including the Technology Marketing Division, is seeking ways to achieve this.

In conjunction with the Alternative Energy Division, the United States Department of Energy, and a number of key bioenergy trade associations,the BTCD is planning a major international bioenergy R&D and business conference for 1991-92.

In conjunction with the Energy Efficiency Division, the Canadian Mortgage and Housing Corporation and EAETB, BTCD will develop a marketing strategy for R-2000 that will involve a major international conference in 1992.

BTCD will continue to seek partners and opportunities for using existing federal facilities to demonstrate EAETB's other novel high-efficiency technologies. This demonstration activity will be followed by active information dissemination on the project.

Resources

Table 8.6
Resource Allocations of the Business and Technology Coordination Division by Category of Expenditure

Financial Resources ($000)

	1990-91	1991-92	1992-93	1993-94
Salary	713.6	608.7	639.1	671.1
Operating	144.0	385.0	405.0	415.0
Contracts	276.0	0.0	0.0	0.0
Contributions	0.0	0.0	0.0	0.0
Capital	5.0	40.0	20.0	10.0
Total	1,138.6	1,033.7	1,064.1	1,096.1

Person-year Resources

	1990-91	1991-92	1992-93	1993-94
Person-years	12	10	10	10

Performance Monitoring

The BTCD has set targets for its outreach activities as follows:

Table 8.7
Key Performance Indicators of the Business and Technology Coordination Division

	1990-91	1991-92	1992-93	1993-94
Professionals to be reached through print	66,500	75,000	75,000	75,000
Clients to be reached through personal contact, seminars, workshops, and so on	300	500	500	500
Business opportunity documents	2	8	10	12
Market analyses	3	5	5	5

9 FOSSIL FUELS TECHNOLOGY BRANCH

Organization

The Fossil Fuels Technology Branch includes two divisions: the Coal Research Laboratories (CRL) Division, and the Energy Research Laboratories (ERL) Division.

The CRL Division develops, demonstrates and enhances coal and oil sands mining and processing technologies.

The ERL Division engages in R&D to improve the efficiency and environmental acceptability of processing and utilization of hydrocarbon-type fuels. It also focuses on ways of improving energy conservation and end-use efficiency.

Fossil Fuels Technology Branch

Coal Research Laboratories

Mission

The impact of CANMET's strategic objectives is apparent in the increased emphasis that the Coal Research Laboratories (CRL) will continue to place on environmental protection in 1992 and 1993. In particular, CRL's mission statement recognizes the environmental issues surrounding both coal and oil sands processing. CRL's Mission Statement is:

"In partnership with industry, CRL develops, demonstrates and enhances coal and oil sands mining and processing technologies, with a special regard for health and safety and environmental acceptability."

Objectives

Within CANMET's strategic framework, CRL's operating objectives provide major thrusts in waste stream technology as well as a continuing responsibility for health and safety R&D in underground coal mining. These efforts maximize the impact of existing resources. The plan encompasses other objectives in environmental technology, and the productivity of fine coal recovery circuits in coal preparation.

The 1991-94 planning period presents CRL Devon (Alberta) with a major challenge in expanding its efforts to look outside the mandated areas of interest in the energy industries of western Canada. The planning period currently presents to other Divisions of CANMET an opportunity to create the essential face-to-face access to many of the key elements of western Canadian industry. Collaborative programs with ERL under the Bitumen Oil Emulsion "sub-sub activity" are continuing; new opportunities are being examined.

Specifically, we are considering a proposal to establish broadly based CANMET activity in western Canada based on the existing resources of CRL. A number of research activities could be enhanced by such an expanded centre. Among these are energy industry applications of biotechnology, H_2S technology in energy processing, and application of surface sciences in mineral processing and the processing of industrial waste streams. The establishment of a western Canadian technological and administrative base for some regional components of the programs run by EAETB would be beneficial.

The advantages to CANMET in establishing a significant effort in western Canada will be very real in terms of consolidating links with regional clients.

Structure of the R&D Program

CRL's research programs fall into a number of areas of science and technology; their delivery reflects the unique regional characteristics of the Division's historic clientele.

Surface Mining	Devon, Alberta
Underground Mining	Cape Breton, Nova Scotia
Coal Preparation	Devon, Alberta
Bitumen Oil Emulsion Technology	Devon, Alberta

During 1989, the Department announced the termination of in-house research by the Surface Mining Laboratory.

The residual contract research program in surface mining is directed towards the definition of environmental-economic linkages in such areas as spoil pile stability and reclamation. It provides a technological support to major joint government-industry technology demonstrations undertaken by the Western Economic Diversification Department.

The underground coal mining laboratory in Cape Breton (The Cape Breton Coal Research Laboratory) was established, following a major fatal disaster, with a specific mandate to improve the health and safety in the submarine mines of Cape Breton.

The research programs of the Fuel Processing Laboratory at Devon provide a balance between the need to ensure an expanding knowledge of the client industries' activities and their impacts on the environment, and to establish the environmental-economic linkages of both existing and innovative technologies for waste-stream treatment.

Within this regional structure, the following program breakdown exists for the period 1991-94. The numbers represent percentage of effort:

Table 9.1
The Coal Research Laboratories' R&D Program

	Protection	Productivity	Policy
Cape Breton			
Coal Research Laboratory	95	0	5
Devon			
Fuel Processing Laboratory	50	50	0
Surface Mining Laboratory	75	25	0

The CRL provides no mandated or routine services to its clientele. All activities demand a creative research input. The existing pilot-plants at Devon provide a major avenue for incremental R&D efforts directed at enhanced fine coal recovery or emulsion separation. The surface sciences and basic science groups, in addition to their input to the incremental activities, are responsible for exploring the concepts that lead to strategic technological developments.

The percentage breakdown for these types of activity is:

Table 9.2
The Coal Research Laboratories' R&D Program by Type of Research

	Strategic	Incremental	Mandated	Exploratory
Cape Breton				
Coal Research Laboratory	15	75	—	10
Devon				
Fuel Processing Laboratory	25	50	—	25
Surface Mining Laboratory	15	85	—	0

Structure of the Division

Program delivery in CRL falls under the control and leadership of two managers—one in fuel processing and one in mining technology. The mining research manager is directly supported by a group leader in Cape Breton. The formal organization of the laboratory that provides for interdisciplinary activity between the operational sections is:

Manager, Mining Research
Research Contracts Coordinator

Group Leader, Cape Breton
Coal Mine Environments
Strata Mechanics
Lab and Field Testing

Manager, Fuel Processing
Oil Emulsion Technology
Coal Beneficiation
Surface Science Applications
Engineering and Field Demonstrations
Special Projects

Marketing

The Research Focus

Surface Mining activities are now restricted to a decreasingly modest contract research program funded by CANMET and continue to support initiatives funded through the western economic diversification programs.

Underground Coal Mining in Canada is dominated by research for the Cape Breton Development Corporation (CBDC) where the clear, continuing emphasis is on health and safety in the environment of mines that continue to operate further from shore line at increasing depth.

Coal Preparation is applied to all of Canada's export coals. The existing process plants have well-established operational procedures, and opportunities for incremental performance improvement are greater than those for the introduction of new capital-intensive technologies. Environmental impact and costs associated with effluent control remain an important target area for R&D.

Bitumen Oil Emulsions produced by the various Enhanced Oil Recovery processes can be anticipated to be an expanding area of CRL activities along with the continuing attention to primary process effluent streams. These effluents represent a key target for collaborative R&D with an expanded client base.

Sludge Disposal is a major challenge to oil sands operators. Sludge is produced in large quantities and is not easily amenable to treatments that allow for its acceptable disposal. CRL has joined with the Alberta Oil Sands Technology and Research Authority, the National Research Council, Alberta Energy, Syncrude, Suncor and the Alberta Research Council in a coordinated study of the fundamental physical, colloidal and chemical properties of the sludge to provide a base for technologies to aid consolidation and disposal.

Hydrogen Sulphide has, with the recent steep increase in sulphur prices, become a source of revenue. Stringent emission regulations, and an available market for H_2, make H_2S treatment to yield H_2 and S a target for the development of electrochemically based processes.

The Clients

CRL's client base continues to broaden as the distribution of the Division's client collaborative program reflects an increasing emphasis on the oil sands industry and significant exploratory R&D efforts based on application of the laboratories' surface science skills to problems existing in the natural gas and mineral industries.

Canadian Coal Supply Industry

The coal supply industry is comprised of 12 producing companies, which are predominantly technology exploiters, adaptors and users. In

the past, R&D has been limited and fragmented. The integration between producer and user is limited to those operations that involve mine-mouth power plants.

Currently, one underground coal mine operates in western Canada and one is under development. The opportunity exists at particular sites to enhance the lifetime and productivity of surface operations using drift (or punch) access to an underground operation. In all surface mining operations, spoil pile stability and control continues to be a technological problem.

Since signing a 1989 Memorandum of Understanding, the Alberta Research Council and CANMET have tabled a proposal for a national coal R&D program in partnership with the Coal Association of Canada. The proposal encompassed a series of technology packages as discrete work units to provide a mechanism for selective industrial support, and a formal mechanism for senior (Chief Executive Officer) level input into the overall direction of the program.

Canadian Oil Sands Industry

The two major oil sands plants in Fort McMurray, Alberta, differ in their approach to R&D. Syncrude Canada Ltd. maintains a major in-house capability in Edmonton covering all technology areas from mining to environmental rehabilitation. Suncor Inc., on the other hand, has no continuing in-house Canadian R&D support, preferring to rely on contract research performers in Canada and abroad. However, interest is high in mining and emulsion technologies, and both companies support R&D in these areas.

Most recently, the development activities associated with the planning and design of the OSLO Project (Other Six Leases Operation) have brought a third industrial group into the research activity of the oil sands mining and processing industry.

Canadian Oil and Gas Industry

The effective application of emulsion technology in the secondary and tertiary recovery of oil and in the demonstration of heavy oil recovery processes is a reality in western Canada. However, not all companies have the analytical capability to perform detailed, systematic and quantitative evaluation of these technologies.

The Canadian Oil and Gas industry, along with the oil sands industry, is a major user of hydrogen and is actively exploring alternatives to conventional natural gas-reforming.

Coal, Oil and Gas Consulting Engineering Profession

In CRL's field of expertise, this profession has little laboratory capability and does not normally carry out R&D except in response to CANMET contract programs. However, consulting engineers play an important role in technology transfer through their collaboration with CRL on joint projects with industry, their work as contractors to CANMET, and their participation in CRL research seminars.

Other Clients

Notable among the list of other clients are manufacturers of specialty chemicals used in the producing industries; provincial and federal agencies (such as the Alberta Oil Sands Technology and Research Authority, the Alberta Office of Coal Research and Technology, the Department of Mines and Energy in Saskatchewan); provincial research councils (such as Alberta Research Council, Saskatchewan Research Council), other government departments (Western Economic Diversification Canada; for example) and equipment suppliers.

Cost-recovery research in non-energy fields on behalf of Dow Canada, Nova Husky, Sherritt Gordon, Noranda and others have shown the breadth of application of some of CRL's surface science expertise.

Communications and Events

The following continuations of CRL's marketing efforts are planned for 1991-94:

- relocation of the divisional business development officer to western Canada (Protocols and links with the central Technology Management Division are now sufficiently well established to make the Ottawa base unnecessary);
- completion of a series of contracted reviews defining opportunities for CRL's major pilot plants both within and external to the energy industries;
- hosting a major showcase conference on oil sands sludge science and technology with the Alberta Oil Sands Technology and Research Authority and Syncrude;
- continued biannual research reviews at operational coal preparation plants;
- establishment, jointly with the Coal Association of Canada, of a Coal Preparation Research Association;
- continuation of public contract research debriefing sessions in eastern Canada;
- consolidation of further consortium-based activities in near infra-red technology, electrocoagulation and H_2S electrolysis; and
- expansion of the Cape Breton Coal Research Laboratory client base and activities in Atlantic Canada.

Strategic Thrusts, Plans and Outputs

Thrusts

CRL's major thrusts fall in three areas:

- health and safety in mining, specifically underground coal mining;
- reduction and utilization of waste streams; and
- yield optimization in fine coal cleaning.

Specific projects in each of these areas are linked to the parallel research of the Mining Research Laboratory, where the responsibility for links with the United States Bureau of Mines is shared, and to the Energy Research Laboratories, where delivery of the Bitumen Oil emulsions sub-sub activity is shared. Links with the Minerals Sciences Laboratory are now re-opening in surface science technologies, following the shutdown of their activity in high sulphur coal beneficiation.

The Cape Breton Coal Research Laboratory, which is a mandated health and safety laboratory serving the Maritime underground coal mining interests of the Cape Breton Development Corporation, and now Westray Inc., is contributing significantly to both cost recovery and collaborative research activities. The formality of the project portfolio definition and progress review in conjunction with the major client has given the laboratory the most clearly defined role in the entire CANMET organization. The 1989-90 achievements of 21 percent of divisional cost recovery and a joint program valued at $2.7 million form a strong base for further achievements during the planning period. The "joint-with-industry" project planning and executive approval of all collaborative R&D is now entrenched; post-project assessment, implementation and impact review is being set up to quantify the value of cooperative research. The research successes of this group will enable it to service the national R&D needs of newly commissioned underground coal mining activities from a successful, experienced base.

Outputs

Specific outputs in the two major thrusts of the Division will be:

Health and Safety in Underground Mining

- establish and assess criteria for the reuse of longwall gateroads (1991);
- demonstrate rock bolting methods for supplementary roadway support (1991);
- assess interactions/subsidence guidelines for the Sydney Coalfield (1992);
- confirm, by application of tracer gas technology, the evacuation guidelines for the Cape Breton Development Corporation emergency preparedness routines (1992);
- develop measures to forecast and control rock/gas outbursts and methane emissions (1993);
- complete a joint evaluation of controlled recirculation ventilation (1993);

- monitor and evaluate the introduction of rockbolting and gate reuse in the Sydney Coalfield (1994); and
- monitor and evaluate strata mechanics and environmental aspects of the introduction of room and pillar mining operations at Westray Coal (1994).

Reduction and Utilization of Waste Streams

- demonstrate, on a pilot-plant scale, the technical and economic characteristics of electrocoagulation technology applied to coal processing plant effluent streams; and
- define the fundamental scientific and engineering parameters that affect the separation of tar sands sludges (waste stream components). This will take the form of work packages initiated under the Sludge Science Consortium and involve CANMET, the Alberta Oil Sands Technology and Research Authority, the National Research Council, the Alberta Research Council, Alberta Energy, Suncor and Syncrude Canada Ltd.

This project represents a major commitment for CRL of three person-years and $600,000 per year for five years; the total budget of the project is more that $5 million.

In addition to these special thrust deliverables, CRL will also deliver a series of program activity outputs. These are planned to be:

Fuel Processing

- a comprehensive understanding of the behaviour of western Canadian low-rank coal during thermal upgrading processes (1991);
- methods for optimizing fine-coal processing circuits in Canadian plants, including the application of on-line monitors and process-control strategies (1992);
- a bench-scale demonstration of Claus tail gas clean up by electrochemical means (1992);
- demonstration of the capabilities of near infra-red technology as a viable on-stream analytical tool for hydrocarbon/water process-stream analysis (1992); and
- comprehensive definition of the geotechnical parametric changes accompanying the pilot and production scale evaluation of the Alberta Oil Sands Technology and Research Authority's Underground Test Facility Demonstration (1993 and ongoing).

Surface Mining

- optimization of dragline performance with New Brunswick Coal (1992);
- mountain waste dump design, monitoring and stability assessments (1993);
- plains Spoil Stability Part II (1993); and
- long-term environmental implications of rock drain structures (1994).

Resources

Table 9.3
Resource Allocations of the Coal Research Laboratories by Category of Expenditure

Financial Resources ($000)

	1990-91	1991-92	1992-93	1993-94
Salary	3,662.8	3,793.8	3,983.1	4,182.5
Operating	2,069.0	1,850.0	1,850.1	1,850.0
Capital	[a]715.0	[a]717.0	[a]636.0	[a]852.0
Contracts	1,599.0	1,379.9	1,197.2	1,126.3
Grants and Contributions	0.0	130.0	130.0	130.0
Total	8,045.8	7,870.7	7,796.3	8,140.8

Person-year Resources

	1990-91	1991-92	1992-93	1993-94
Person-years	61	62	62	62

a Reduced by $198,000 in 1991-92, $279,000 in 1992-93, and $63,000 in 1993-94 as a transfer to EAETB (Varennes).

Table 9.4
The Coal Research Laboratories' Research Distribution by Program

Financial Resources ($000)	1990-91	1991-92	1992-93	1993-94
Coal Reserves Assessment	127.2	0.0	0.0	0.0
Surface Mining	300.0	50.0	0.0	0.0
Underground Coal Mining	1,901.6	1,986.2	1,969.2	2,013.8
Coal Preparation	3,120.1	3,259.1	3,231.2	3,304.2
Coal Desulphurization	147.2	0.0	0.0	0.0
Management & Support	899.1	867.3	859.5	897.2
Coal Bed Methane	0.0	132.3	150.0	222.6
Treatment Bitumen/oil Emulsions	1,475.6	1,443.5	1,429.8	1,493.0
Hydrogen Sulphide	0	132.3	156.3	210.0
Total	8,045.8	7,870.0	7,796.3	8,140.8

Person-year Resources	1990-91	1991-92	1992-93	1993-94
Coal Reserves Assessment	1	0	0	0
Surface Mining	4	1	0	0
Underground Coal Mining	15	17	17	17
Coal Preparation	21	24	25	25
Coal Desulphurization	0	0	0	0
Management & Support	12	12	12	12
Treatment Bitumen/oil Emulsions	8	8	8	8
Total	61	62	62	62

CRL has established a world-leading role in the parallel application of electronic and optical microscopy and structural characterization techniques to industrial waste stream disposal problems. This role is partly a consequence of discriminating capital investments over the past decade. This state-of-the-art capability will erode rapidly under the Capital budget profile shown above. See Tables 9.3 and 9.4.

Performance Monitoring

The principal key performance indicator is the level of cost recovery. The "accelerated" levels, reflecting a postulated enhanced flexibility for CANMET/CRL, are shown below:

Table 9.5
Key Performance Indicators of the Coal Research Laboratories

	1989-90	1990-91	1991-92	1992-93	1993-94
Cost-recovery					
Target ($000)	420.0	600.0	770.0	1,000.0	1,100.0
Actual ($000)	457.0	[a]250.0			
Client Share in Collaborative R&D					
Target ($000)	425.0	500.0	1,100.0	1,500.0	2,100.0
Actual ($000)	1,080.0	[a]4,441.0			
Clients Share in Cost-shared R&D					
Target (%)	34.4	34.4	37.5	37.5	37.5
Actual (%)	31.0				
Secondments					
to CRL	—	1	2	3	4
from CRL	1	2	2	2	3

a As of September 1, 1990

Fossil Fuels Technology Branch

Energy Research Laboratories

Mission

The mission of the Energy Research Laboratories (ERL) Division is to engage in R&D to improve the efficiency and environmental acceptability of processing and utilizing hydrocarbon-type fuels, and to improve energy conservation methods and end-use efficiency.

Active cooperation is sought with industry, including cost recovery where appropriate for the work. In addition to enhancing energy security and supply, ERL now accords priority to reducing the environmental impact of fossil fuel use. Leading to cleaner and more efficient use of resources, ERL's R&D makes an important contribution to sustainable development. ERL joins industry under the guidance of external advisory groups to maximize the industrial benefit of its activities, to exploit opportunities for technical innovation, and to develop technologies that address regulatory requirements.

Objectives

Specific objectives of ERL's R&D initiatives are:

1. to sustain the future competitiveness of, and to expand market opportunities for, the Canadian fossil fuel industry by advancing knowledge and by developing more advanced technologies for the efficient recovery, upgrading, and use of Canada's bitumen, heavy oil, natural gas and coal;

2. to support public health and safety by promoting energy-efficient technologies that minimize environmental impact (particularly the greenhouse effect and acid rain) by: developing cleaner fuel processing technologies, improving fuel utilization processe, and improving the quality and performance of fuel products and energy systems through contributions to national and international standards; and

3. to support the development and implementation of government policies related to security of energy supply and the environment.

Structure of the R&D Program

In the past, ERL devoted approximately 60 percent of its efforts to R&D designed to improve industrial productivity, approximately 30 percent to protection of people and the environment, and 10 percent to federal policies. Two changes have taken place over the past two years: more projects have been implemented with specific environmental goals, and many of the productivity and policy projects have embodied environmental goals and components. Where projects have multiple goals, division into the categories of productivity, protection and policy is somewhat subjective. However, a current view is that 40 percent of ERL's efforts are aimed at productivity, 45 percent at protection, and 15 percent at policy, standards and regulations.

Organization

ERL is comprised of three research laboratories, a technology commercialization group and administrative staff. The three laboratories are the Synthetic Fuels Research Laboratory (SFRL), the Combustion and Carbonization Research Laboratory (CCRL) and the Fuels Characterization Research Laboratory (FCRL). SFRL addresses recovery and upgrading of heavy oils and bitumens, secondary upgrading, hydrocarbon catalysis, utilization of refinery residue, and hydrogenation of coal and solid wastes. CCRL addresses combustion mechanisms, equipment development, control of emission of pollutants from combustion, efficiency in energy conversion and energy systems, coal gasification, and the production and use of metallurgical fuels. FCRL addresses fuel and feedstock analysis; it takes the lead role in Canada in the establishment of new national and international analytical standards. The Technology Commercialization Group deals with program planning, program assessment, and business development.

Market Strategy

Clients and Market Niches

Oil and Gas Industry

Canada's largest fossil fuel energy resources are the tar sands and heavy oils of western Canada. The development of these resources is important to Canada's future energy needs, especially during times of uncertainty in world oil supplies.

ERL provides research support for extraction, upgrading, and residue utilization of heavy crude oil and tar-sand bitumen. Catalysis research is performed to improve production of synthetic fuels and chemical feedstocks while giving consideration to environmental concerns, in particular the utilization of wastes. Coprocessing of coal with heavy oil to form a high-quality refinery feedstock is also being developed, to convert lower-rank western Canadian coals into marketable liquid products. With the increase in environmental concerns, ERL is addressing new ways of modifying fuels to improve air quality, and in eliminating wastes from fuel production.

Canada is in a unique position, with its large reserves of natural gas. In addition to using this gas as a commodity (high-grade fuel, for example), natural gas can be converted to higher-valued products using processes that have much less of an environmental impact than those for oil or coal. ERL addresses options to expand the role of natural gas in meeting national energy and environmental needs. Primary emphasis is on developing, jointly with industry, catalysts and catalytic processes for converting natural gas and its components (methane, ethan and condensates) into transportation fuels, fuel additives and petrochemicals.

Coal and Steel Industry

Canada exports about 28 million tonnes of coking coal annually (principally to Japan and other Pacific Rim countries) and uses about

eight million tonnes domestically in metallurgical processes. ERL provides technical support to the coal and metals industries by developing technologies that: improve fuel quality and efficiency in thermal and metallurgical processes; lower the environmental impact of producing and utilizing carbonaceous materials; use coke and alternative fuels in blast furnace and other metallurgical processes; and improve the coking behaviour of coals to produce high-quality coke while ensuring safe and efficient industrial operation.

Electrical Utility Industry

Coal is used to produce 16 percent of the electricity generated in Canada, and will continue to be one of the least expensive primary energy sources. ERL provides technical support to utilities to develop technologies that reduce formation of acid gases in the combustion process, capture acid gases with furnace sorbents, and integrate coal gasification technology to Canadian needs. Also, ERL develops technologies and system approaches for electricity production to improve the overall thermal efficiency, minimizing pollutants as well as costs.

ERL is providing a new thrust in the area of technology development, dissemination and commercialization to accelerate the integration of energy systems with electricity production. The goal is a marked improvement in energy efficiency and reduction of CO_2 and other emissions.

Other Environmental and Energy-related Industrial Needs

Increasing environmental concerns have caused ERL to focus on the development of technologies that use industrial process wastes as fuel or petrochemical feedstock. These include products from sewage treatment processes, waste products from pulp and paper processes, municipal wastes, hydrocarbon and coal water emulsions, waste oils, and plastics. ERL has specialized analytical services to examine the quality of, and test the performance of, carbonaceous fuels and chemical feedstocks derived from wastes. Also, ERL takes a national leadership role on behalf of the Canadian fuel industry by participating in the setting of national and international fuel standards.

Cooperative Research and Development

To a large extent, ERL's research program is market-driven. Part of ERL's mandate is to conduct strategic research to help support future Canadian industrial needs. ERL encourages cooperative research in the following ways:

Contracted R&D

ERL contributes over $6 million annually to support industrial energy research. This support is accessed through CANMET's Energy Conservation Program and ERL's Request for Proposals Program.

Joint Agreements

ERL enters into joint agreements with its clients and has the flexibility to design programs to suit clients' specific needs.

Research and Development Consortia

ERL offers clients an opportunity to join research and development consortia. Generally, ERL supports half the cost of the R&D while other consortium members split the remaining costs between them. The consortia provide clients with industrially oriented research in a highly cost-effective manner.

Secondment

ERL encourages secondment to and from industry to promote technology transfer, to improve its scientists' industrial experience, and to develop highly qualified personnel.

Networking

ERL represents Canada on over 20 international committees, and enters into cooperative agreements with other countries (particularly through the International Energy Agency) to share technology advancements in areas of particular interest to Canada. This networking capability continues to play a very important role in capitalizing on international technological opportunities, which are passed on to the private sector.

Strategic Thrusts, Plans and Outputs

Strategic R&D Thrusts

ERL is a diversified energy R&D laboratory. Its technical expertise and influence cover a broad range of activities. These are bitumen and heavy oil recovery, upgrading and conversion; natural gas conversion to liquid fuels and petrochemical feedstock; coal utilization, combustion and metallurgical fuels; energy-efficient systems and energy conservation. In all these fields, ERL seeks avenues for cooperative research with industry.

More emphasis has recently been applied to efficiency in the use of energy. ERL is thus responding to the concerns of Canadians for protection of the environment. Acid rain, ozone depletion, global warming (mainly by CO_2 build-up in the atmosphere), municipal and industrial waste are issues being addressed.

ERL is concentrating on the rational use of energy and reduction of CO_2 emissions in the fuels production/conversion industry. For example, energy consumption and CO_2 emissions can be reduced through more efficient use of process heat, by integrating stages in oil upgrading processes and through more efficient use of hydrogen. Equally important is the management of produced wastes, particularly upgrader solid residues and atmospheric emissions of sulphur and

nitrogen. ERL is taking a lead in ensuring that environmental protection is an important criterion for all new heavy oil technologies. Also, ERL works cooperatively with Environment Canada and the private sector to support new environmental legislation affecting transportation fuels. ERL bases its continued development of advanced technologies for the production of cleaner fossil fuels on its established expertise in reaction engineering, process development and catalytic processing.

ERL addresses analytical problems generated by processing non-conventional feedstocks, products and wastes. Standard analytical methods are often inadequate and need to be modified through research. ERL participates in the development of international codes and standards to ensure that Canadian resources are properly assessed and are competitive in the international market. Leadership in standards activities ensures that environmental aspects, such as toxic trace elements, are considered by industry when standards are prepared.

The efficient use of fuels is the most effective way to minimize the emission of pollutants, lower operating costs and improve productivity. Increasing efficiency, optimizing fuel use, and using combustion technologies that reduce the emissions of acid gases are vital elements of this approach. ERL will continue to develop energy technologies that minimize acid gas and CO_2 emissions, especially from the combustion of coal, as well as carbonaceous residues from bitumen upgrading.

The integration of energy systems will provide further major opportunities to improve energy efficiency and realize the ensuing environmental and other benefits to society. These include security of energy supply, ability to switch fuels, utilization of industrial and municipal waste heat, and cost-effective use of renewable energy resources. Integrated energy systems, especially advanced cogeneration combined with district heating/cooling and pollution abatement technologies, offer the best opportunities for improving in energy efficiency.

Program Plans and Outputs

Recovery of Bitumen, Heavy and Light Oils

In western Canada, bitumen and heavy-oil resources are vastly greater than conventional oil resources. As production of conventional light oil declines, a greater supply of heavy oil and bitumen will be required to meet the demand for fuel. Through a coordinated national program with agencies such as the Alberta and Saskatchewan Research Councils, the Petroleum Recovery Institute and the Alberta Oil Sands Technology and Research Authority, ERL supports the work of many companies conducting enhanced oil recovery process R&D for several large Canadian reservoirs. Environmental protection is emphasized.

Treatment of oily wastes from heavy oil production, cleaning and reuse of produced water, and prevention of gas emissions to the atmosphere are being addressed. The reuse of CO_2 recovered from electricity generating stations for EOR is also being explored.

Major projects are:

- advanced horizontal well technologies (1990-93);
- novel soluble-vapour gravity-assisted and steam-assisted in-situ combustion (1991);
- microbial enhanced oil recovery (MEOR) (1991); and
- field trials of novel bitumen recovery technologies; horizontal well steam flooding in Saskatchewan; microbial plugging and foam blocking in Alberta (1991-93).

Bitumen and Heavy Oil Upgrading

The objective of this technology is to upgrade heavy oil and oil sands bitumens to cleaner, low-carbon fuels that emit less CO_2 when burned. Economic pressure, coupled with environmental concern over fossil fuels contribution to global warming, increases the need for new, cost-efficient technologies that integrate economic efficiency with environmental concerns. To address this challenge, ERL has formed industrial research consortia with emphasis on emerging technologies that have commercialization potential. The direct benefits to Canadian refiners will be the development of practical methods for improving the cost-efficiency of existing upgraders.

Major projects are:

- Feedstock Reactivity Consortium, Phase I: determining new correlations for the hydrocracking reactivity of a vacuum residuum (1991);
- establishing an industrial consortium on reactor dynamics for synfuel processes (1991);
- developing gamma ray densitometry methods for a new upgrading process application (1992);
- developing biological and membrane methods for removing of contaminants from bitumen (1992);
- establishing a consortium on catalysts for heavy oil upgrading (experimental program 1991-1994);
- establishing a consortium on heavy oil emulsion upgrading (experimental program 1991-1994); and
- establishing a consortium on jet reactor upgrading (experimental program 1991-1994).

Synthetic Crude Oil Refining

ERL applies advanced concepts in catalyst design to solve problems associated with processing Canadian synthetic crude oil into clean transportation-grade fuel. Canadian refineries are under increasing pressure from stricter environmental standards and from the shift of Canadian resources to increasingly heavier and dirtier feedstocks. New cost-effective refining technologies are essential to avoid deterioration in the quality of Canadian distillate fuels and to maintain the competitiveness of the Canadian refining sector. ERL is addressing this challenge through its network with Canadian refineries, through dialogue with Environment Canada on environmental technical issues on fuels processing, engine design changes, gasoline additives and reformulations, and through in-house R&D on new refining catalysts that reduce the aromatics in diesel and jet fuels and that better withstand the naturally occurring catalyst poisons in the oil.

Major projects are:

- a technical study of catalyst poisons removed from synthetic gas oil for paving asphalt additives (1991);
- an improved catalytic process for nitrogen removal from Lloydminster synthetic fuels (1992);
- development of a new process for the regeneration and recycling of refinery catalysts (1992);
- a technical and economic study of a membrane process to remove aromatics from diesel and jet fuels (1993); and
- development of a new integrated hydrocracking-hydrotreating process for producing cleaner transportation fuels (1993).

Residue Conversion and Utilization

Upgrading heavy oil and bitumen to transportation fuels creates large quantities of low-value by-products (pitches, tars and cokes) that are environmentally unacceptable and have poor market prospects. ERL has developed new technologies to turn residue into valuable products and is continuing to work with industry to improve these and create other market applications. Also, existing technologies are being adapted to process related industrial wastes such as those from petrochemical and plastics production and from municipal waste-water treatment plants. ERL has initiated a comprehensive R&D program to convert hydrocarbon wastes, such as used tires, oils and plastics into upgraded fuels and petro chemical feedstock.

Major projects are:

- establishing with industrial and provincial partners a consortium for the conversion of hydrocarbon wastes into refinery distillates (1991-92);

- developing a process to convert organic wastes into transportation fuels (1992-93);
- bench-scale assessment of rubber industry waste oils in asphalts (1992); and
- developing additives to improve asphalt compatibility for recycling aged pavement (1994).

Natural Gas Conversion

ERL's research consortium on natural gas conversion was established to stimulate development and commercialization of superior technologies to convert natural gas and other light alkanes into marketable liquid fuels and chemicals, and to encourage industry to share in this R&D. Tighter environmental standards and a growing concern over global warming from CO_2, methane and other light hydrocarbons have challenged the industry to adopt cleaner gas-processing options.

ERL has in-depth expertise in catalyst development and in designing novel processing routes that are needed to help Canadian industry create new markets for methane-derived products. Active areas of natural-gas R&D include production of raw petrochemicals and fuel octane boosters.

Major projects are:

- experimental studies and environmental assessment of electrochemical conversion of natural gas (1992);
- assessing technologies for removal of carbonyl sulphide and carbon disulphide from natural-gas processing plant emissions (1993); and
- completing Phase I and Phase II program objectives for the research consortium on natural gas conversion (1991-1994).

Coal-Oil Coprocessing

Coprocessing is a technology that combines upgrading of coal and oil to produce clean transportation fuels. Compared with heavy oil upgrading it has the advantage of replacing relatively expensive heavy oil with lower-cost coal. Coprocessing is potentially viable in western Canada because of the close proximity of coal, oil and natural gas reserves. Technology transfer has begun with the formation of a consortium of industrial partners to further develop an engineering database for commercialization.

Major projects are:

- completing the technical program for Phase I of the coprocessing consortium (1992-93); and
- collaborating and exchanging information with the

U.S. Department of Energy under a memorandum of understanding (1990-93). The Alberta Research Council is also participating in this exchange.

Coal Gasification

ERL's R&D in coal gasification supports Canadian industrial interests in integrated gasification combined-cycle technology (IGCC). This technology converts coal to electricity with lower emissions of acidic species and particulates. Also, the higher thermal efficiency achieved by IGCC creates lower emissions of CO_2 per unit of generated electricity. Projects have been defined and are being carried out in cooperation with the Canadian Electrical Association, the Coal Association of Canada, the Coal Gasification Technical Committee, and individual utilities.

Coals are evaluated at ERL in an entrained bed pilot plant for Canadian electric utilities. The results are used for feasibility studies that select an optimal gasification process, as part of IGCC technology. Also, Canadian coals are evaluated for their suitability as feedstocks for different gasifiers, the objective being to help mining companies market their coals for gasification purposes in Canada and abroad.

Research on hot gas clean-up focuses on low-cost solids as sorbents for removing acidic species before the gasifier products are burned. Activated carbon produced from eastern Canadian coals are being evaluated for environmental applications.

Major projects are:

- establishing process parameters for entrained bed gasification of coal (1990-94);
- evaluating ERL-developed sorbents that remove acidic compounds from gasifier products (1991);
- conducting an economic assessment that compares electricity generation using ERL's developed hot gas clean-up sorbents with conventional technologies (1992);
- developing a process to produce and evaluate the properties of activated carbon from eastern Canadian coals (1992); and
- evaluating high-temperature fuel cells for use with coal gasification products (1993).

Metallurgical Fuels and Carbon Science

ERL's metallurgical fuels and carbon science research facilities include pilot-scale coal handling, coke ovens and coke testing facilities. ERL works closely with industry on metallurgical fuel-related problems through joint research projects, particularly with the Canadian Carbonization Research Association (CCRA). The joint technical efforts

of ERL and CCRA have been a major factor in achieving recent increases in metallurgical coal exports. ERL also works closely with the Canadian steel industry and a chemical producer through CCRA to improve their operations and product quality, to conserve fuel and energy, and to minimize environmental impacts.

Major projects are:

- designing and developing a pilot facility to simulate injection of alternative fuels into blast furnace tuyères (1991); then determining devolatization and combustion properties of injected coals (1992);
- discovering the effects of coke-oven operating parameters on coal blends containing only western Canadian coals (1991);
- determining the influence of impurities in coal on the hot strength of coke (1992);
- optimizing coal cleaning methods for yield and coking properties of Canadian coals (1993);
- reducing environmental, handling, and coking concerns of dust and fines in western coals (1993);
- determining the potential for disposing of automobile tires in coke ovens (1993);
- assessing petroleum residue suitable for upgrading to non-carcinogenic binders for production of carbon electrodes for aluminum smelting (1993); and
- supporting development of a pilot plant to study an environmentally benign continuous coke-making process (1994).

Industrial Combustion

ERL uses its pilot-scale combustion facilities to generate data for industry on the handling, combustion and emissions performance of coals, and the performance of stack-gas clean-up systems. ERL conducts long-term R&D on combustion kinetics and develops advanced models and laser-based, non-intrusive measurement technologies for better, more relevant information to increase utilization efficiency and reduce emissions of pollutants.

ERL has ongoing research programs in new combustion technologies such as micronized coal, oil in water emulsions and coal-water fuel (CWF) that could replace gas or oil in existing boilers and industrial combustors, often with environmental advantage. ERL examines the performance of these fuels and combustion technologies in association with advanced burner concepts. Clients include Canadian coal producers, the oil industry, electric utilities, cement companies, and industrial boiler users.

Major projects are:

- assessing the influence of coal properties and micronization parameters on combustion and emissions characteristics (1991);
- developing advanced measurement and prediction techniques for coal combustion (1992);
- publishing Volume 3 of *Combustion Performance and Emission Characteristics of Canadian Coals* (1993); and
- resolving burner atomizer wear problem and developing of scale-up criteria for the CANMET CWF/oil burner (1993).

Combustion Technologies for Pollution Abatement

ERL has extensively addressed pollution abatement through collaborative projects with industry, universities and other government agencies. The Division developed criteria for burners and combustion systems for suppressing nitrogen oxides and soot-formation. It evaluated in-furnace injection of sorbents to control sulphur oxides, and recently initiated a program to measure trace elements in fuel and fuel-ash residues.

ERL aims to accelerate the development of fluidized-bed-combustion technology through pilot-plant studies and technical support of major demonstration projects. This technology combines efficient use of otherwise unmarketable fuels such as low grade coal, refinery residues and burnable wastes, with 90 percent reduction in emissions of SO_2 and NO_x. Clients include coal-burning utilities, oil-sands mining and utilization interests, and the Coal Association of Canada. Advice on technically achievable emissions levels is provided to regulatory agencies for incorporation into pollution control standards. Other activities include developing technologies and strategies to take the methane from waste sites and coal mines, and using it in industrial boilers, and developing high-efficiency, low-NO_x gas burners for certain industrial processes.

Major projects are:

- developing and validating a computer modelling technique for designing sorbent-injection systems for SO_x control in existing wall-fired boilers (1991);
- identifying, evaluating and promoting in-boiler technologies that minimize NOx and SO_x emissions from utilities and industrial combustion systems (1992);
- commissioning and operating a 1-MWth pilot-scale circulating fluidized-bed-combustion unit capable of burning 100 kg/h of low-grade fuel in accordance with environmental requirements (1990-1994);
- developing a database for the fluidized-bed-combustion and emission performance of coke and pitch residues from

- oil-sands and heavy-oil upgrading (1992); and
- developing analytical trace-element protocols for fluorine, selenium, and leachates from combustion residues, and completing industry consensus standards for sulphur forms and arsenic (1993).

Energy-conservation Technology

Increasing efficiency is the most effective way to lower emissions of carbon dioxide, the major greenhouse gas. ERL pursues research in improved combustion technology and the optimization of operational conditions in both the domestic and industrial domains. The goal is to increase fuel efficiency in all applications. This work includes ensuring safe operation, lessening impact on the environment, and integrating improved, fuel-efficient technology into new, efficient systems. Techniques are developed to reduce emissions of incomplete combustion products (CO_2, hydrocarbons, soot and other particulates) and other combustion-derived pollutants such as NO_x. Advanced oil-furnace retrofit packages can reduce emissions by 25 percent, and condensing gas furnace retrofits can save more than 30 percent. Combined space and hot water systems for oil and gas offer even greater potential, with increased suitability for new, low-energy housing.

Research continues on methods that allow clean burning of lower-grade blends of middle-distillate heating oil, enabling transfer of the better quality portions to higher-valued transportation fuels. This work is carried out jointly with Canadian oil companies and close cooperation is maintained with industry associations, the U.S. Department of Energy, and the appropriate standards organizations.

ERL's program on residential wood-burning appliances aims for efficiency, safe venting, and maintenance of good indoor-air quality. Canadian advanced-combustion wood stoves emit 80 percent less incomplete combustion products than conventional stoves. ERL provides detailed input and guidance to Canadian building and appliance codes and regulations.

ERL is developing expert systems technology and combustion-process simulation for industrial processes, so that energy use may be optimized.

Major projects are:

- establishing detailed performance criteria for middle distillate fuels in stationary combustion applications (1991);
- defining optimal conditions for combined space and water heating for oil- and gas-fired systems (1992);
- developing retrofit technology for oil and gas heating systems to reduce fuel consumption and CO_2 emissions by

25 percent and 35 percent respectively (1992);
- drafting and implementing, as a national standard, procedures for measuring aromatics in middle distillate fuels as a basis of combustion performance for the Canadian General Standards Board (1992);
- determining the technical feasibility of using methane from coal mines and other waste sites in industrial boilers to reduce greenhouse gas emissions (1991);
- conducting combustion trials on alternative biomass-processed fuels to assess emissions-reduction potential (1991);
- establishing emissions and efficiency standards for residential wood-burning appliances (1991); and
- developing and operating expert systems on a pilot scale (1992), and on an industrial combustion system (1993).

Integrated Energy Technologies

Linking electricity production with industrial processes and space heating enables the recovery and utilization of otherwise wasted or rejected heat. Through combined heat and power production, or cogeneration, it is possible to decrease energy use and the resulting emissions by as much as 40 percent. Furthermore, by integrating building cooling systems with central chillers, it is possible to increase overall efficiencies by using low-grade heat or steam at central power plants to drive the chillers. System efficiencies can also be increased by ensuring access to lower temperature heat sinks such as lakes, rivers or ground water. Central chilling displaces CFC use and alleviates summer electrical peaking problems by replacing electrically driven air conditioners and assembling large-scale thermal and electrical loads (demand-side management).

ERL's program focuses on developing more efficient and cost-effective technologies to assemble and manage thermal energy loads through state-of-the-art district heating and cooling and, through analysis, identifying opportunities for systems-integration.

Major projects include:

- analyzing non-technical barriers to district energy systems, including cogeneration, and developing a marketing manual (1991);
- developing and commercializing friction-reducing additives for district heating and cooling pipelines (1991);
- conducting a detailed analysis of environmental benefits of district energy systems, for the International Energy Agency (1991);

- developing an ice-slurry design manual for district cooling (1992); and
- developing and demonstrating an integrated utility telemetry system for load-control and system-performance monitoring (1993).

Resources

Table 9.6
Resource Allocations of the Energy Research Laboratories by Category of Expenditure

Financial Resources ($000)

	1990-91	1991-92	1992-93	1993-94
Salary	9,835.1	9,723.6	10,077.1	10,443.3
Operating	3,902.0	3,894.0	3,944.0	3,994.0
Capital	1,741.0	1,668.0	1,474.5	1,990.5
Contract	5,398.0	4,780.0	5,351.0	5,383.0
Contributions	763.0	910.0	640.0	700.0
Total	**21,639.1**	**20,975.6**	**21,486.6**	**22,510.8**

Person-year Resources

	1990-91	1991-92	1992-93	1993-94
Person-years	162	158	156	154

Table 9.7
Energy Research Laboratories' Research Distribution by Program

Financial Resources ($000)

		1990-91	1991-92	1992-93	1993-94
Recovery of Bitumen		300.0	310.0	320.0	330.0
Heavy and Light Oils	Contracts	1,917.0	1,630.0	1,900.0	1,900.0
	Contributions	620.0	570.0	300.0	300.0
Bitumen and Heavy Oil Upgrading		3,230.0	2,140.0	2,140.0	2,200.0
	Contracts	579.0	400.0	400.0	400.0
Synthetic Crude Refining		1,700.0	1,820.0	1,850.0	2,000.0
	Contracts	572.0	500.0	500.0	500.0
Residue Conversion and Utilization		0	790.0	810.0	990.0
	Contracts	0	250.0	300.0	300.0
Natural Gas Conversion		935.0	955.0	975.0	1,000.0
	Contracts	310.0	300.0	350.0	350.0
	Contributions	40.0	40.0	40.0	0.0
Coal-oil Coprocessing		800.0	825.0	850.0	875.0
	Contracts	200.0	100.0	100.0	100.0
Coal Gasification		750.0	830.0	850.0	900.0
	Contracts	300.0	250.0	250.0	250.0
Metallurgical Fuels and Carbon Science		1,525.0	1,670.0	1,730.0	1,800.0
	Contracts	100.0	100.0	100.0	100.0
Industrial Combustion		1,120.0	1,145.0	1,180.0	1,180.0
	Contracts	468.0	400.0	450.0	450.0
Combustion Technologies for Pollution Abatement		1,945.0	1,850.0	1,735.0	1,970.0
	Contracts	452.0	350.0	500.0	530.0
	Contributions	103.0	300.0	300.0	400.0
Energy Conservation		960.0	990.0	1,020.0	1,100.0
	Contracts	225.0	225.0	226.0	228.0
Integrated Energy Technologies [c]		160.0	165.0	174.0	200.0
	Contracts	275.0	275.0	275.0	275.0
Management & Administration		2,053.1	1,795.6	1,861.6	1,882.8
Total		**15,478.1**	**15,285.6**	**15,495.6**	**16,427.8**
	Contracts	**5,398.0**	**4,780.0**	**5,351.0**	**5,383.0**
	Contributions	**763.0**	**910.0**	**640.0**	**700.0**

a Incorporated within the above technical programs are 24 P-Ys dedicated to analytical support, development of national and international standards and development of new analytical techniques.

b Incorporated within Management & Administration is the Technology Commercial Group (7 P-Ys).

c "Integrated Energy Technologies" is a major ERL initiative of the Environment Agenda (*The Green Plan*); a planned increase in resources is not yet approved.

Table 9.8
Energy Research Laboratories' Person-year Resources by Program

Person-year Resources	1990-91	1991-92	1992-93	1993-94
Recovery of Bitumen Heavy and light oils	3	3	3	3
Bitumen and Heavy Oil Upgrading	37	26	25	24
Synthetic Crude Refining	18	19	19	19
Residue Conversion and Utilization	0	7	7	7
Natural Gas Conversion	7	7	7	7
Coal-oil Coprocessing	8	8	8	8
Coal Gasification	6	7	7	7
Metallurgical Fuels and Carbon Science	19	19	19	19
Industrial Combustion	12	12	12	11
Combustion Technologies for Pollution Abatement	14	12	11	11
Energy Conservation	10	10	10	10
Integrated Energy Technologies	2	2	2	2
Management and Administration	26	26	26	26
Total	**162**	**158**	**156**	**154**

Performance Monitoring

The indicators in Table 9.9 have been established to help assess performance and monitor industry's participation in ERL's program.

Table 9.9
Key Performance Indicators of the Energy Research Laboratories

	1989-90	1990-91	1991-92	1992-93	1993-94
Cost Recovery ($000)	1,250.0 (1,118.0)	1,650.0	2,030.0	2,350.0	2,775.0
Leverage of Funds ($000)	3,400.0 (3,963.0)	4,000.0	5,000.0	6,000.0	6,000.0
Secondments (Person-years)					
to ERL	2 (1.2)	3	3	3	3
from ERL	2 (1.8)	2	2	2	2
Client's Share of Cost-shared R&D (%)	31.6 (42.5)	34.4	37.5	37.5	37.5
Patents and Licences (Number)	7(6)	9	9	9	9
Seminars (Number)	3(3)	3	3	3	3

Unbracketed numbers represent targets; bracketed numbers represent actuals.

10 MINERAL TECHNOLOGY BRANCH

Organization

The Mineral Technology Branch is composed of three complementary groups of laboratories: the Metals Technology Laboratories (MTL), the Mineral Sciences Laboratories (MSL), and the Mining Research Laboratories (MRL).

MTL develops technology to improve the competitiveness of the Canadian metals industries, to enable the best materials and engineering technology to be used, and to enhance demand for metals products.

MSL conducts and sponsors both research and engineering development across the spectrum of mineral technologies from mineralogy and metal extraction and refining to waste management and mineral products.

MRL conducts research and development in explosives technology and in all areas of mining except coal, oil sands, and explosives technology.

Mineral Technology Branch

Metals Technology Laboratories

Mission and Objectives

The Metals Technology Laboratories Division aims to enhance health and safety, and protect the environment by developing technology in partnership with industrial clients.

MTL strives to:

1. increase the competitiveness of the Canadian metals industries;
2. encourage the use of the best materials and engineering technology for improved reliability and productivity of mineral and hydrocarbon resource acquisition, processing, and transportation equipment; and
3. enhance demand for products of the Canadian metals industry through commercialization of advanced materials and development of new products.

Structure of the R&D Program

MTL's research program is organized into highly focussed programs in five major areas of technology.

Steel Technology

MTL conducts research to assist the Canadian steel industry to meet the challenges of increasingly stringent processing and product specifications and reduced costs. This includes collaborative research on casting, rolling, forming, coating and metallurgy of steels.

Foundry Technology

MTL helps the Canadian foundry industry by conducting research that emphasizes the adoption of environmentally acceptable technologies. This includes projects on recycling of foundry wastes, permanent mould casting, and application of computers to foundry process control.

Materials for Resource Industries

MTL conducts research to enable the safe and environmentally sound recovery and transportation of Canada's mineral and energy resources. These projects include work on oil and gas pipelines, defect-assessment in pressure vessels, materials for the mining industry, fatigue and fracture of welded joints in offshore structures and in ships, corrosion and corrosion control.

Advanced Metallic Materials

MTL assists Canadian industry in taking advantage of market opportunities provided by the development of new materials and products. Projects include advanced magnets, metal matrix composites and surface modification technology.

Non-ferrous Products

MTL develops technology to assist the base-metal industry to increase the worldwide market for products of the non-ferrous industry. This program reacts to industry initiatives and currently includes sponsored projects on corrosion of magnesium, continuous casting of copper, and advanced batteries.

Within each of these technologies, research in support of industrial productivity, health, safety and environmental protection, and policy development and implementation, is conducted depending on the nature of the technology, its relation to MTL's mandate and its role in Canadian society. The more competition-oriented the technology is, the greater the percentage of MTL's work in support of productivity. Thus foundry technology and steel technology concentrate on productivity by researching in direct support of industry, with less emphasis on protection and policy, although protection of the environment is taking on an increasingly important role. In other areas, however, particularly materials for resource industries where structural and material reliability present environmental and worker safety-hazards, a high percentage of the work is in support of protection and policy.

Table 10.1
The Metals Technology Laboratories' R&D Program

	Average Percentage Thrust		
Technology Program	**Productivity**	**Protection**	**Policy**
Steel	75	15	10
Foundry	70	25	5
Materials for Resource Industries	30	30	40
Advanced Metallic Materials	50	10	40
Non-ferrous Products	85	10	5

MTL also administers a national program for certifying non-destructive testing personnel in Canada to standards set by the Canadian General Standards Board. This activity falls primarily within the "protection" category.

The research program contains elements of strategic, incremental, mandated and exploratory research, but the percentages vary depending on the program area. During the past three years a major initiative has been organizing and conducting joint research projects with industry that generally fall in the category of incremental

research. Indeed this has been so successful that MTL has experienced a reduction in exploratory research to very low levels and specific efforts will be made during the planning period to increase the level of exploratory research to 10 percent of program. All research programs are guided by advice from Technical Advisory Groups composed of industry experts.

The following table shows the present approximate distribution of effort among the five technologies and the Non-destructive Testing Personnel Certification Program.

Table 10.2
The Metals Technology Laboratories' R&D Program by Technology

	Percentage			
Technology Program	**Strategic**	**Incremental**	**Service**	**Exploratory**
Steel	45	45	5	5
Foundry	60	20	15	5
Materials for Resource Industries	50	40	5	5
Advanced Metallic Materials	70	15	5	10
Non-ferrous Products	50	50	—	—
NDT Personnel Certification	—	—	100	—

Organization and Structure

MTL has a staff of 120 people; approximately 20 administrative support and management personnel, 50 technologists and 50 scientists and engineers. The research program is managed within a matrix structure, with a coordinator for each of the five technologies reporting to the Manager, Technology Program, and five research section heads reporting to the Manager, Laboratory Operations. The Non-destructive Testing Personnel Certification Unit reports to the Manager, Services to Industry, while the Technical Publications and Administration groups report directly to the Director.

Marketing Strat[illegible]

Major Clients and Market N[illegible]

[illegible]lients are many and varied, and come from several diverse [illegible]s of Canadian industry. These clients have been divided into [illegible] groups, aligned with MTL's research programs and [illegible]e Testing Personnel Certification. A Technical Advisory [illegible]sed primarily of industry representatives has been form[illegible]dvise MTL management on the direction of the research within each of the technology programs.

Steel Technology

The clients of the steel technology program are the primary steel producers. The steel industry is an important client of CANMET, with activities in mining, mineral processing, energy utilization as well as steel production, and is the domestic supplier of various specialized engineering products underpinning the entire resource and manufacturing industries. MTL interacts with steel producers, both large and small, on an individual basis and also under a general Memorandum of Understanding with the Canadian Steel Industry Research Association (CSIRA). Research with the steel companies is centred on the unique Canadian facilities of MTL, such as the pilot-scale rolling mill, the cam plastometer, and melting and casting facilities of the MTL foundry. Experimental sheet, plate and shaped products are produced and process variables are investigated for many companies and research organizations in Canada. In joint programs with the steel industry, MTL has developed mathematical models of the rolling process that are being used to predict the rolling schedules required to obtain the target thickness and properties of hot rolled steel. Major clients are Stelco, Dofasco, Algoma, Ipsco, QIT Fer et Titane, Ivaco, Lasco, Slater Steel, and CSIRA.

Foundry Technology

MTL works with many Canadian foundries, from small, traditional operations to the large, highly automated high-productivity foundries of the automotive parts industry. The $2 billion foundry industry produces value-added products directly for the resource industries and the manufacturing sector. It is an important link in the mineral chain, and is important in regional development and in meeting the needs of local industry. The increasingly stringent demands of environmental regulations, strong price competition from offshore suppliers, and a reduction in general economic activity has put some Canadian foundries out of business during the past several years, others are under severe pressure. MTL is working to assist these foundries to meet the demands of the 1990s.

The MTL Technical Advisory Group on foundry research has advised that research focus on environmental concerns, mainly related to sand use and disposal, permanent mould technology, and production systems that lower costs and increase product quality. MTL has developed and demonstrated software for improving cost-control and efficiency of electric furnaces and cupola melting. This software is increasingly being used by Canadian foundries and their suppliers. These continuing developments, plus other initiatives in low-pressure die casting, evaporative foam casting, and the production of austempered ductile iron products, have made MTL the Canadian technology centre for the foundry industry. Specific clients include the Canadian Foundry Association, Enviromelt, Quality Steel Foundries,

ESCO, Deloro Stellite, Ontario Hydro and the Centre de recherche industrielle du Québec.

Materials for Resource Industries

MTL's clients range from steel companies developing better tubular products and linepipe, to the oil, gas and pipeline companies that use these products, from the mining industry and their suppliers to government departments and agencies that regulate various sectors of the resource industries.

With the energy resource industries, MTL focuses on materials technology for economical, safe and environmentally benign recovery, processing and transportation of hydrocarbons. Major MTL clients are the tubular and linepipe producers, the major pipeline companies, the petrochemical supply industry, and standards-writing organizations such as the Canadian Standards Association. MTL also works closely with the Canadian Coast Guard to provide materials technology related to arctic ships that must comply with the Canadian Arctic Shipping Pollution Prevention Regulations.

MTL, in cooperation with the Mining Research Laboratories, is working with wire-rope producers and provincial regulatory authorities to develop improved methods of inspecting mine hoist cables. In association with the Nickel Development Institute, a rock-bolt manufacturer and several Canadian mines, MTL is investigating the use of stainless steel rock bolts for improved long-term ground control. MTL is also working with major mines to investigate improved wear- and corrosion- resistant materials, and will increase efforts in this field during the planning period. Some specific clients are Babcock and Wilcox, Nova, Esso, Shell, Dupont, Ontario Hydro, Syncrude, Petro Canada, Fleet Technology, Polysar, B.C. Hydro, Trans Canada Pipelines , the Department of National Defence's Defence Research Establishment Pacific, the Canadian Coast Guard (Transport Canada), Canadian Oil and Gas Lands Administration, Paprican, Deloro Stellite, Nickel Development Institute, Wire Rope Industries and the Ontario Ministry of Labour.

Advanced Metallic Materials

Major clients who benefit from this program include Canada's major base-metal mining companies such as Inco, Cominco and Noranda, and specialty-metals producers such as Timminco. MTL is also working with a variety of smaller high-tech companies, such as Ceramics Kingston, as potential downstream users of the products of this technology. Guest scientists from aerospace companies such as Hawker Siddeley Canada Inc. work at MTL on specific projects.

Non-ferrous Products

This new program was developed to be responsive to the needs of the non-ferrous products industry in Canada. Projects are started only after a funding agreement has been reached with a particular client, or a group of clients represented by industry associations. Projects are under way for the International Magnesium Association, the Kidd Creek Division of Falconbridge Ltd., Inco Ltd. and Rayovac. Other proposals have been submitted to the International Copper Association, the International Lead Zinc Research Organization and the Canadian Copper and Brass Development Association, among others.

Non-destructive Testing (NDT) Personnel Certification

MTL operates the national program for the certification of NDT personnel in Canada on a full cost-recovery basis. There are nearly 3,000 individuals, employed by over 700 companies, research organizations and consultants, certified under this program. An advisory committee composed of representatives of the clients of the program advises MTL management on all aspects of the program. Major employers of certified personnel include: Stelco, Dofasco, Algoma, Air Canada, Canadian Airlines International, Ontario Hydro, Québec Hydro, B.C. Hydro, the Department of National Defence, Atomic Energy of Canada Ltd., Babcock & Wilcox, and Nova.

Promotion and Communication Activities

MTL promotes its research capabilities through publications, presentations, conferences, workshops, seminars, site visits and newsletters. MTL staff play an important role within the Canadian Institute of Mining and Metallurgy organizing technical sessions for both the Annual General Meeting and the Conference of Metallurgists. Staff are active in a variety of other international technical associations and meetings and conferences of these organizations to promote MTL research opportunities.

MTL organizes seminars, workshops and conferences and, in cooperation with various Canadian chapters of the American Foundrymen's Society, holds foundry workshops across the country every year.

MTL periodically publishes a foundry newsletter and recently distributed its first newsletter for the clients of the NDT personnel certification program.

Specific activities during the planning period include:

- publication of a catalogue of MTL facilities;
- publication of factsheets on key technologies;

- a 1992 international conference on pipeline reliability in Calgary;
- a proposed joint CANMET-Canadian Advanced Industrial Materials Forum in 1992; and
- a proposed 1992 Canada-U.S.S.R. conference on the composition and integrity of structures in arctic service.

Strategic Thrusts, Plans and Outputs

Foundry Technology

Strategic thrusts of the Foundry Technology Program are the following:

1. gravity permanent-mould casting of high-melting point alloys and demonstration of this technology in a Canadian foundry;
2. procedures and software for real-time process control of cupola operations and foundry sand systems; and
3. recycling of foundry sands in association with the Canadian Foundry Association's Committee on Sand Reclamation.

Specific research projects, each carried out in conjunction with one or more clients, have been developed to meet the objectives of these strategic thrusts. Most of these projects involve some cost-recovery research.

Specific outputs include the following:

- demonstrating procedures for casting cobalt-based alloys in water-cooled copper moulds (1990);
- developing guidelines for procedures for producing cast-iron in permanent moulds (1991);
- conducting a workshop in association with the Canadian Foundry Association on all aspects of sand reclamation and environmentally benign methods of disposal (1991);
- demonstrating real-time control of a "cokeless cupola" (1992); and
- demonstrating real-time control of a green-sand system at a Canadian foundry (1992).

Steel Technology

Research on steel technology is divided into four major projects, each with one or more strategic thrusts aimed at assisting the Canadian steel industry to control costs and improve products. Strategic thrusts are the following:

1. with the Projet Bessemer consortium, development of strip-casting technology;
2. in conjunction with CSIRA, development of laboratory procedures to allow simulated direct rolling of con-cast steel billets;
3. developing medium-strength grades of Interstitial Free (IF) deep drawing quality steel for the automotive market;

4. developing compositions and processing technology for producing, in Canada, weldable HSLA (High-strength, Low-alloy) 80 and 100 steel plate suitable for use in constructing arctic ships and offshore structures;
5. verifying the mathematical model METFORM, and extending this model to include microstructure and property prediction for an industrial rolling mill; and
6. applying and adapting the technology of microalloyed plate steels to the direct production of shaped products.

Specific outputs of these thrusts include the following:

- laboratory simulation of strip casting; water modelling of the nozzle of a two-wheel strip-casting machine, and evaluation of the properties and rolling characteristics of strip-cast sheet; all including cost-recovery or signed agreements with Projet Bessemer Inc.;
- demonstrating MTL's capability to simulate the direct rolling of continuously-cast billets by ingot casting, stripping, and rolling (1992);
- defining composition limits for improved IF (interstitial free) steels (1992);
- demonstrating galvanizing and galvannealing procedures for use with an improved medium-strength IF steel (1993);
- optimization of HSLA 80 and 100 compositions and processing procedures to meet strength, toughness and weldability requirements for marine and structural applications (1992);
- delivering an off-line modelling package capable of predicting microstructure and properties for selected carbon steels and microalloyed steels (1993); and
- in conjunction with a steel company and an automotive parts producer, defining composition and processing procedures for microalloyed special bar-quality billet steels that may be directly forged to products (such as automotive steering components) without heat treatment (1992).

Materials for Resource Industries

Strategic thrusts of the Materials for Resource Industries Program include the following:

1. establishing fatigue and fracture performance data, fabrication procedures and inspection and protection systems to permit the construction in Canada of offshore structures and arctic icebreakers;
2. developing technologies associated with the fabrication, inspection and repair of high-temperature pressure vessels used in the petrochemical and electric utility industries;
3. developing technology for improving the reliability of oil

and gas pipelines and of oil country tubular goods; and

4. developing materials technology to enhance safety and productivity in the mining industry.

Specific outputs from these four strategic thrusts include the following:

- producing guidelines on stress-relief, post-weld heat treatment of tubular joints for offshore structures (1991);
- completing the demonstration and evaluation of engineering critical assessment (ECA) methods applied to pressure vessels (1991);
- determinating hydrogen concentrations in operating pipelines (1991);
- developing weld procedures for repair of service-damaged Cr-Mo steel pressure vessels and components (1992);
- creating guidelines for avoiding weldment corrosion for normalized plate used in icebreakers (1992);
- international Conference on Pipeline Reliability (1992);
- publishing the results of field testing of stainless steel rock-bolts in Canadian mines (1992);
- developing a methodology to reduce growth-rates of soil-side stress corrosion cracks in operating pipelines (1993);
- developing a software package for design and residual life predictions for welded tubular joints (1994); and
- establishing guidelines for NDT methods of inspecting mine-hoist wire ropes (1994).

Advanced Metallic Materials

Research on advanced metallic materials is directed in a variety of areas, including advanced alloys and products, metal matrix composites, surface modification technologies, near-net shape forming, and advanced materials characterization. Major strategic thrusts are the following:

1. assisting industry to develop and adopt advanced processing technologies for specific metal products, with emphasis on advanced magnets, high-temperature intermetallics, metal matrix composites, surface modification technology, and near-net shape forming; and
2. developing the advanced materials characterization methodology required for in-depth analysis of new materials.

Some of the major outputs from this program include:

- developing a process for fabricating hot-worked advanced magnets (1992);
- assessing nickel aluminide coatings for the corrosion-erosion protection of boiler tubes in fossil-fuel-fired electric-utility boilers (1993);

- low-pressure, permanent-mould cast product characterization of zinc-based composites (1994);
- assessing the benefits of surface-modification technologies on wear-resistance and thermal fatigue of ferrous alloys (1992);
- assessing technologies for control and refinement of microstructure in direct-cast non-ferrous strip (1993); and
- evaluating technologies for characterization of grain boundry segregation (1993).

Non-ferrous Products

This technology program is designed to react entirely to industrial initiatives for funded research on non-ferrous product development. The strategic thrust is therefore to assist the non-ferrous industry to expand the market for its products. Outputs of full cost-recovery projects are confidential to the client.

Specific milestones include:

- a report on copper anode production (1991);
- a report on near-net shape-formed nickel (1991);
- fabrication of Mg-Li alloys for advanced batteries (1991); and
- progress reports on the Fundamental Corrosion Study of Magnesium (1991, 1992, and 1995).

Management and Administrative Thrusts and Associated Outputs

Although the scheduled downsizing has proceeded, significant rejuvenation through new hirings has continued at a very satisfying pace. Of the current complement of 52 person-years in the Scientific and Professional Category, 18 percent were hired between 1989-90 and 1990-91. In addition, MTL met its 1993 target for francophone representation, as well as its 1991 target for female representation. The MTL allocation of 126 person-years for fiscal 1990-91 will drop to 119 in 1993-94. Rejuvenation will continue, but at a more normal pace compared to the rapid rate of change in the scientific category over the last three to four years. With the accompanying reduction in average age of the group, occasions for new hirings will be reduced to a steady rate.

Looking ahead to the 1990s, all forecasts indicate a shortage in North America of scientists with graduate degrees, especially at the Ph.D. level. Competition for available graduates will be very intense in Canada, and between Canada and the U.S. The current MTL ratio of 35 research scientists to 15 physical scientists is considered lower than desirable to achieve the scientific leadership required for the challenges and conflicting demands of the future. MTL, in the context of diminishing resources and competition for new graduates, is partially addressing this problem by cross-category transfers of physical scientists to research scientists through extramural doctorate achievements. Currently, six physical scientists are taking doctoral degrees.

Increasing the number of females in the research scientist group is a very specific objective. Few females who study engineering continue to the Ph.D. level. Only one of the six physical scientists in MTL working toward a doctoral degree is female. Good liaisons have been established with universities in order to establish better contacts with female graduate students. At the same time, strong consideration will be given to offering opportunities for doctoral degrees to female physical scientists who are hired in the future.

After the scientific and professional category, the next stage of revitalization will be the Engineering and Scientific Support Group. This revitalization is already underway as opportunities are created by staff separations. The rate of change will inevitably be less than that of the scientific groups for which supplementary temporary person-years were made available.

The Engineering and Scientific Support Group has undergone a classification restructuring and will play a more vital and expanded role during the 1990s. A combination of restructuring, continuing revitalization, increased levels of formal education, departmentally sponsored, focussed training, and modern technology will inevitably, through good management, change the character of this group from support to professional. Inherent in this change would be a significantly modified relationship between the scientific and support groups and a more individual, comprehensive and direct role for members of the support group in MTL technology activities. MTL anticipates that this broadened personal responsibility and job enrichment will enhance the capability of MTL, and help to offset recent and continuing person-year reductions.

Language training for both francophone and anglophone groups will continue with increased vigour in order to promote a harmonious bilingual working atmosphere.

Resources from Other CANMET Units

The largest amount of direct support will be required from the Engineering and Technical Services Division. It will need to provide 25-30 percent of its person-year resources because of the planned acquisition of major new equipment between 1990 and 1993, and because of program developments.

The current use of one person-year in the Mineral Sciences Laboratories for chemical analysis, principally for the Foundry Section, will continue.

Research in corrosion and degradation of engineering structures, surface modification and ductility in strand cast steel will require a continued estimated 200 hours of access by MTL staff to the Auger facility at the Energy Research Laboratories.

The main support required from the Technology Marketing Division (TMD) and the Research Program Office (RPO) will be ongoing as defined by their mandates, existing levels of activity and recently negotiated accords. The TMD will be called on to print reports and proceedings from technical symposia (500 copies per year) as well as promotional material (5,000 brochures per year, of two to four pages each).

Resources

Table 10.3
Resource Allocations of the Metals Technology Laboratories by Category of Expenditure

Financial Resources ($000)

	1990-91	1991-92	1992-93	1993-94
Salary	7,528.4	7,324.2	7,626.0	7,871.6
Operating	1,986.0	1,737.0	1,737.0	1,737.0
Capital	1,366.0	1,376.0	1,326.5	1,458.5
Contracts	900.6	[b]914.9	[b]914.9	[b]915.9
Total	**11,781.0**	**11,352.1**	**11,604.4**	**11,983.0**

Person-year Resources

	1990-91	1991-92	1992-93	1993-94
Person-years	126	120	119	117

a temporary adjustments included
b includes $100,000 of Industry, Science and Technology Centre's "AI Funding"

Table 10.4
Metals Technology Laboratories' Research Distribution by Program

Financial Resources ($000)

	1990-91	1991-92	1992-93	1993-94
Foundry Technology	1,444.6	1,301.2	1,278.3	1,460.0
Steel Technology	2,343.5	2,361.8	2,312.5	2,290.0
Materials for Resource Industries	3,917.7	3,705.6	3,732.1	3,725.0
Advanced Metallic Materials	1,740.9	1,706.5	1,763.0	1,805.9
Non-ferrous Products	538.0	728.4	913.0	1,020.0
Non-destructive Testing	588.6	614.6	628.7	722.5
Management & Administration	1,207.7	934.0	976.8	959.6
Total	**11,781.0**	**11,352.1**	**11,604.4**	**11,983.0**

Person-year Resources

	1990-91	1991-92	1992-93	1993-94
Foundry Technology	16	14	13	13
Steel Technology	22	21	20	20
Materials for Resource Industries	35	32	31	30
Advanced Metallic Materials	18	17	17	16
Non-ferrous Products	6	8	10	10
Non-destructive Testing	7	7	7	7
Management & Administration	22	21	21	21
Total	**126**	**120**	**119**	**117**

Performance Monitoring

Table 10.5
Key Performance Indicators of the Metals Technology Laboratories

	actual	target			
	1989-90	1990-91	1991-92	1992-93	1993-94
Cost Recovery ($000)	1,249.0	1,279.0	1,625.0	2,115.0	2,255.0
Client's Share of Task-shared Projects ($000)	2,118.0	1,000.0	2,100.0	2,500.0	4,150.0
Client's Share of Cost-shared Work (%)	60.0	34.4	37.5	37.5	37.5
Secondments (Person-years)					
to MTL	2	3	3	3	3
from MTL	2	4	2	2	2

Mission

Mineral Sciences Laboratories (MSL) is responsible for supporting and delivering constituent elements of departmental programs. As a technology centre, MSL serves industry, government departments and agencies with technology development and advice.

This Division's activities provide input for decision-making on a diverse range of technological issues related to the industrial exploitation of Canadian mineral resources. Expertise in MSL supports the need to contribute to improved health, safety, and environmental quality and to sustain Canada's minerals industry. MSL also takes a leadership role in developing advanced technology for building viable new industries for the 21st century.

MSL strives to maintain a working environment conducive to innovation, dedication and common purpose and at the same time is supportive of personal aspirations. Opportunities exist for employees to enjoy working on interactive and interdependent projects in an atmosphere of mutual respect.

Objectives

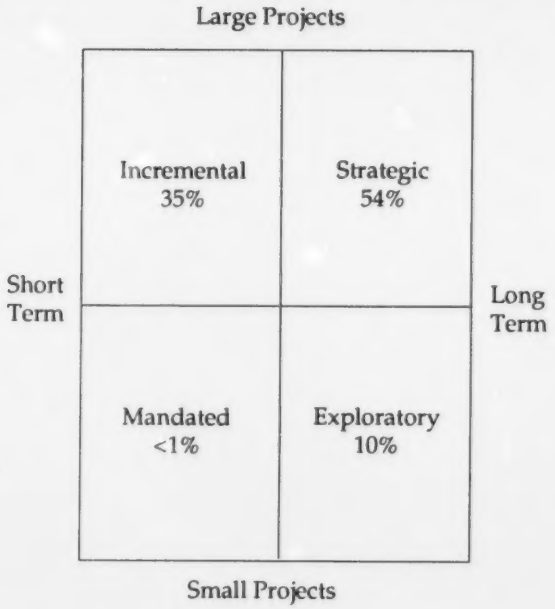
MSL has refocussed its efforts into four key programs that have these objectives:

- minimizing the environmental impact of discarded mineral-processing wastes through the development of low-cost treatment and disposal technologies;
- conserving and extending the Canadian resource base through recycling and reuse of process wastes and materials during their lifecycle;
- increasing the productivity and international competitiveness of the Canadian mineral industry, through improved resource utilization; and
- enhancing the Canadian economic base through the more efficient industrial application of strategic technologies: biotechnology, advanced materials (ceramics) and information technology.

Structure of the R&D Program

MSL plans to undertake work in the four categories of research and development indicated in Figure 10.1. The distribution of effort is planned to be 8 percent policy, 34 percent protection and 58 percent productivity.

Figure 10.1
Mineral Science Laboratories' R&D Distribution by Category



Organizational Structure

MSL is organized along disciplinary lines as indicated in Figure 10.1. Scientific and technical personnel reside in three laboratories: Mineral Processing, Extractive Metallurgy and the Chemical Laboratory. Also reporting to the Director are the Administrative Group, the Mine Environment Neutral Drainage Program (MEND), a Senior Metallurgical Advisor and the Office of Business Development.

MSL is reorganizing to meet the needs of the refocussed program orientation and to support increasing business demands. The reorganization is out of phase with the business planning cycle and therefore cannot be set out in detail. The reorganization will establish the definitive role and responsibility for meeting the key performance indicators, including cost recovery in the Office of Business Development. This office will be responsible for marketing, client liaison and project management of projects for non-EMR clients. The line laboratories will be responsible for performing all scientific and technical work and for the direction and performance of EMR-funded R&D. The new structure will improve service to clients through clearly defined responsibilities and accountabilities in meeting business objectives.

Marketing Strategy

Clients and Products

MSL is client-driven. Clients include individuals in corporate offices, operations and technology development centres in industrial companies, and individuals in EMR and other government departments.

MSL's primary client is the federal government. In addition to EMR, MSL's clients include Environment Canada, Industry, Science and Technology, and the National Research Council.

MSL also serves a very large number of industrial clients. In 1989-90, MSL performed over 100 cost-recovery projects for almost an equal number of clients. This broad range of clients is best outlined in terms of three areas of interest.

Base Metals

There are some 170 metal mining operations in Canada, of which some 50 have base-metal milling operations. MSL has unique facilities in mineralogy, modelling and mineral dressing to serve the needs of these companies.

There are also some 15 base-metal operations in Canada that engage in further processing. These operations use smelting, refining, leaching, solution purification and electrolytic processes, and are served by the wide range of technical experts in MSL.

The environmental impact of sulphidic wastes is a particular concern because of the potential for the production of acid mine drainage. MSL acts as the coordinator for the industry-government MEND program. Liquid wastes from mills and stack gases from smelters present challenges for the development of improved technology.

Precious Metals

Canada has more than 60 mills treating gold and other precious metal ores. The conventional approach of cyanidization of gold ores is easily applied; the technological challenge is to optimize the processes in terms of process control, metal recovery and environmental control.

The environmental concerns raised by cyanide have demanded more research. Cyanide destruction and cyanide recycling are being evaluated under site-specific conditions.

New primary and secondary sources of platinum-group metals have presented processing challenges.

Other Industrial Client Groups

The Canadian mineral industry also includes over 200 industrial minerals plants. This segment of the industry is served through the unique expertise available in the Mineral Processing Laboratory.

Other clients served, although to a lesser extent, include the aluminum, pyrochlore (niobium) and tantalite industries. These comprise some 25 operations.

Products

The federal government's objectives in economic development, environmental protection and social action are effected through the redistribution of funds. It seeks a bridge to industry over which its policies and initiatives can be conveyed.

The government requires a broad technological knowledge-base to effectively appraise changing demands and priorities. Canada's high-quality, successful national laboratories enable the government to respond comprehensively to industrial needs and to anticipate changing priorities in the technology marketplace.

MSL fulfils the needs of its government clients by providing information for policy direction; performing services for regulation and trade; working with industry to expand industrial technological activities; and encouraging human resource development in science and technology.

The objective of the Canadian mineral industry is to maximize its profits. It strives to be knowledgeable about government initiatives that have an impact on industrial activity. Insights into longer-term technological trends and alternative approaches to resolving problems enhance industrial competitiveness. Risk-sharing by the Government promotes the development of new technologies to strengthen the industrial base. Industry strives to augment its capability by developing or gaining access to a highly competent and knowledgeable pool of scientific and engineering personnel, acting as a human expert system.

MSL, as a technology centre, serves its industrial clients by providing information, performing services, and transfering technology, and acts as a gatekeeper for technology. The industrial requirement for research and engineering development is met through the conduct and sponsorship of studies, and the application of technology. The needs and objectives related to specific technological challenges are identified through ongoing liaison and discussion with people at the operations, research and management levels.

Marketing Activities

Business Development

MSL will serve its clients through ongoing discussions to identify their needs, and by detailed planning. The Division will plan, execute and manage projects according to scope, deliverables, budget and schedule. These will be developed and pre-defined with, and agreed to by, the client.

To ensure that schedule, budget and deliverables are forthcoming, MSL has installed a computerized project management system for tracking the progress of all projects.

Performance Targets

MSL's performance for its industrial clients is measured by a set of key performance indicators.

MSL has no policy or mandated base load for cost recovery. To meet ever-increasing targets, especially as they relate to cost recovery, MSL will require a focussed business development activity. Integration of technology and business development with present and future business goals, effective support systems and strong administrative support will be developed.

Business Development Office

The focus of the Business Development Office will be to ensure attainment of key performance targets. Meeting these targets will become a specific management responsibility.

The office staff will serve as the primary interface between MSL and its industrial clients. In consultation with the laboratory staff, the office will develop marketing plans, identify and develop business opportunities, prepare proposals, negotiate cost-recovery contracts, cost-shared and joint agreements, and liaise with the client during and after project completion. In addition, business development staff will ensure that, for external projects, the scope and deliverables are met.

The office will be organized along commodity lines to more effectively interact with MSL's industrial clients.

Strategic Thrusts, Plans and Outputs

MSL will maintain its commitment to quality as a world-class laboratory. An ongoing investment in the growth of MSL will be sought based on a continued demonstration of a return to its investors — government and industry. The Division will secure more substantial financial commitments from industrial clients.

Management Initiatives

MSL will build on its strengths and uniqueness and take a leadership position in competing for the limited funds that the industry is willing or able to invest in technology development. It will be flexible when performing its activities and delivering its programs, to ensure a close interface with government and industry agendas.

MSL's interdisciplinary capabilities and depth of expertise give it a unique advantage in providing solutions and advice on minerals technology challenges faced by government and industry. These assets will be brought more into focus through the organization of interdisciplinary projects and project teams. MSL is reorienting its operation from one that is discipline-based to one that is project-based.

Service

A comprehensive understanding of the client's need is essential to the delivery of expected results. MSL's clients expect and deserve reliable results, produced on schedule and on budget. This requires continuing dialogue with clients and close attention to changing factors.

Regionalization

The central location of MSL in Ottawa serves the need for close interaction between interdisciplinary groups and reduces duplication of services and facilities. The synergy of all activities being centrally located brings different viewpoints to bear on many of industry's long-term challenges. It enables close interaction with government clients, such as the staff of the Industry Science and Technology Centre, the National Research Council and Energy, Mines and Resources. On the other hand, it has had the effect of isolating some staff from close contact with industry. This is particularly the case for industries located some distance from Ottawa.

MSL management will review and analyze the costs and benefits and, if appropriate, recommend locating some of the laboratory facilities and expertise in other parts of Canada. If relocation is appropriate, than the most workable approach is to focus a new and well-defined initiative in an appropriate region. Potential candidates for such a new establishment are biotechnology, ceramics and environmental protection.

Managing Change

MSL is rapidly changing from a discipline-driven organization to one that is driven by client needs. The changes are significant and real; not only in terms of program and structure but, more importantly, in terms of people. MSL management, in consultation with CANMET management, is establishing a clear direction. Through a consultative process with MSL staff, we will achieve change through commitment to common goals.

Management Deliverables

MSL intends to:

1991-92

- meet key performance indicators;
- reorganize its business development function and focus along commodity lines;
- evolve from a discipline-based to a client-driven, interdisciplinary, project-based operation;
- recognize MSL's leadership role in technology development by a 25 percent increase in the average dollar-value of fully funded, cost-recovery contracts;
- maintain a working-environment conducive to innovation, dedication and common purpose;
- develop a mechanism for focussing MSL's role as a gatekeeper of technology for medium- and smaller-sized companies;

1992-93

- meet key performance indicators;
- implement the role of gatekeeper for medium- and smaller-sized companies;

1993-94

- meet key performance indicators; and
- enhance the gatekeeper role.

Environmental Protection

Technological Initiatives

Increasing public concern for the protection of the environment has resulted in the need to develop a more integrated and focussed technology program in this field. MSL has been a significant developer of technology related to environmental protection; undertaking more activities with resource utilization-oriented objectives.

MSL is redirecting its activities in the environmental area. Existing project work will be reviewed and reoriented to meet program objectives. MSL continues to coordinate the industry-led, cooperative (industry-provincial-federal) MEND program. New initiatives will be developed during the initial stages of this planning period. These will require the re-assignment of MSL personnel and the recruitment of new professional and technical staff to further augment this critical area. Discussion and close liaison with regulatory agencies and operating companies will be an essential part of project execution and technology transfer.

Specific initiatives in place and being developed include:

- expanding the coordination role for in-house support and contract support of the MEND program for acid mine drainage mitigation;
- waste management systems and close-out technology development for base metal operations;
- potash tailings disposal; and
- atmospheric pollutant sensor development for sampling and measurement.

Deliverables

MSL plans to:

1991-92

- develop and implement a focussed program in environmental protection with input from industry and regulatory agencies;

- document and transfer to industry a study on fixation of arsenic from smelter gas;
- organize the International Conference on Abatement of Acid Mine Drainage;
- define and implement the expanded MEND coordination role;
- verify the biological degradation process for airport de-icers in a pilot plant and make recommendations on commercialization;
- evaluate electrochemical mediation of acid mine drainage through an on-site trial;

1992-93

- document and transfer to industry a feasibility study fixing toxic metallurgical sludges in concrete;
- define and document mechanisms of acid mine drainage in mine wastes and the use of biological systems for its amelioration; and

1993-94

- commercialize biological mediation of acid mine drainage.

Recycling

Technological Initiatives

Recycling mineral wastes offers several benefits to society and industry. The conservation of materials and energy, increased revenues, and the reduced environmental impact of wastes offer significant incentives to develop technologies to recycle, reuse and recover what is now considered waste.

Many of the principal metals such as iron, lead and copper are recycled. MSL is taking initiatives in the conversion of "waste materials" to products, and in developing a longer term program to address opportunities in mineral recycling.

The focus during the first two years of the planning period will be on conversion of waste into products such as:

- fly ash in concrete;
- refractories recovery;
- foundry sand reuse;

and by-product recovery such as:

- values from anode slimes;
- zinc and lead from steelmaking dusts; and
- precious metals from zinc pressure leach residues.

A more comprehensive and coordinated effort in recycling technology will be developed in collaboration with industry, the Mineral Policy Sector, and the Efficiency and Alternative Energy Technology Branch. This will include identification, characterization and utilization of mineral wastes through:

- waste inventory development;
- physical, chemical and mechanical property analysis;
- process development; and
- applications evaluation.

Deliverables

MSL will:

1991-92

- develop a focussed recycling technology program, and develop projects in collaboration with industry, the Mineral Policy Sector and the Efficiency and Alternative Energy Branch;
- commercialize the AVR process for cyanide recovery from gold plants;
- transfer magnetic separation technology for wastes to the non-aluminium industry;
- develop and publish an engineering database on the properties of mine backfill incorporating copper slag as a binder;
- organize a conference on durability of concrete;

1992-93

- publish and transfer to industry a report on mechanical properties and durability of high-volume fly-ash concrete ;
- organize a conference on the use of fly-ash, silica fume and slag in concrete; and

1993-94

- ensure that biological recovery of selenium from smelter effluents in commercial operation.

Resource Utilization

Technological Initiatives

With declining ore grades and a highly competitive international market, Canada must strive to realize the full value of its resource base. With mining costs frequently constituting 80 percent of the expense of mineral production, process inefficiencies represent a significant lost opportunity cost.

The thrust of the MSL initiative in resource utilization is to improve process economics through increased recovery, and to develop new systems for improved process control, reduced labour requirements and higher-quality products. The benefits of maximizing recoveries are decreased costs, reduced environmental impact and lower energy consumption. A more complete and comprehensive understanding of process parameters and unit operations will improve process economics and the competitiveness of Canadian industry. Current MSL activities address:

- integration of image analysis data into circuit design development, and modelling for plant control;
- column flotation operational optimization;
- enhanced recovery of iron ore;
- expanded applications of industrial minerals;
- chemistry of metallurgical processes for process control;
- use of selective and aggressive systems that are economic for the dissolution of metals in hydrometallurgical systems; and
- application of metal separation, recovery and purification technologies with improved economics for gold, precious metals, base metals and rare earths.

These will be reviewed, and a refocussed program developed with industry input.

Standards have been used to create trade barriers. The development of agreed-to and accepted standards for international trade, and enhanced quality control, will increase market accessibility for Canadian products, as will improved characterization of materials and policy guidelines.

MSL activities in response to this need include:

- certified standard reference materials;
- measurement methods development;
- quality assurance systems; and
- participation in national and international standards organizations.

Deliverables

MSL will:

1991-92

- publish a review of the behaviour of sphalerite, galena, chalcopyrite, silver, gold and tin from Canadian volcanogenic ores;
- complete an evaluation of one application of the Ferric

Chloride Process under cost recovery;
- develop a freeze-thaw durability test on high-strength concrete;
- produce a summary report of ten previous Canadian Standards Association round-robin comparative cement testing programs;

1992-93

- oversee sales of reference materials that reach $200,000;
- make a decision on the commercialization of the Ferric Chloride Process;

1993-94

- transfer to industry results from grinding mill optimization studies for iron ore plants;
- transfer to industry gold ion exchange in-plant resin-in-pulp technology; and
- demonstrate application of the laser probe in improving mineral process recoveries.

Strategic Technologies

Technological Initiatives

The long-term economic development of Canada depends on the advance of technology. The Industry Science and Technology Centre has identified key technologies as "critical". These are advanced materials, biotechnology and information technologies.

The benefits to Canada of strategic technologies development are projected for the longer term. Their recognition as key technologies has led to a substantial government investment to raise the awareness and interest of the industrial community. Government funding and research support are critical in sustaining current efforts. When such technologies will be sufficiently mature to be a major job-creation mechanism is uncertain.

MSL has for many years had an established and recognized development program in all of these technologies.

Ceramics technology development is conducted to support a fledgling Canadian industry. The principal thrusts relate to:

- provision of advice through the C^3 (CANMET Ceramics Consulting) Users Group;
- development of functional ceramics such as piezoelectrics;
- evaluation of opportunities for new materials and new applications; and

- coordination of efforts with MTL and other research groups.

A new thrust will be to develop in Canada a greater awareness of the use of ceramics through applications research and discussion with the user industry, for example, ceramics as sensor materials. Furthermore, technology developed at MSL will be used as a lever with offshore companies in an attempt to create jobs in Canada.

Biotechnology has found a niche in the mineral and energy field with the recovery of products from mined-out stopes, and the mitigation of environmental impact. MSL has been and will continue to be active in this field.

Projects that will continue during the planning period include:

- control of bacterial leaching mechanisms to prevent acid mine drainage;
- biological mitigation of acid mine drainage through sulphate reduction;
- specific metal sorption for in-plant separation of metals and end-of-pipe environmental protection;
- degradation of organics in mineral processing plants to reduce process upset and to enhance water recycling;
- microbially-enhanced oil recovery through reservoir plugging;
- control of biofouling and biocorrosion;
- biodegradation of refinery sludges to reduce environmental impact; and
- networking and information exchange with Canadian industry.

Information technologies have mushroomed in recent years. MSL is helping to aid industry acquire and apply such technologies. Activities at MSL will be expanded to encompass:

- expert system gatekeeping;
- dynamic modelling of metallurgical plant processes;
- sensor development;
- process control system testing; and
- computerized training modules.

Deliverables

MSL intends to:

1991-92

- redirect ceramic efforts thrust to include applications research and offshore investment in job creation;
- implement spiral process control strategies in the iron ore industry;
- identify for commercial use applications for wear-resistant oxide matrix materials containing hydrothermally-processed zirconias;
- evaluate the performance under industrial conditions of a H_2 sensor prototype for transfer to industry;
- expand information technologies program in consultation with industry and the National Research Council;
- commercialize flow-injection analyzer for toxic cyanide in gold mill effluents;

1992-93

- develop a prototype sensor to monitor SO_3 in process gases;
- demonstrate on a laboratory scale a process for production of beta silicon carbide powders;
- develop dynamic simulation for metallurgical process plants;
- complete a comprehensive report on generic bioleaching mechanisms and the role of oxygen;

1993-94

- demonstrate integration image analysis and material balance models for improved concentrator performance;
- commercialize a sensor to monitor SO_3 in process gases; and
- demonstrate on a laboratory scale improved behaviour of candidate pyroelectric materials through process optimization.

Resources

Table 10.6 shows the overall allocation of person-years, contract funds and capital for the current year and the three years covered by the business plan. Table 10.7 shows the resources allocated to each of the areas of major technology development.

Table 10.6
Resource Allocation of the Mineral Sciences Laboratories by Category of Expenditure

Financial Resources ($000)

	1990-91	1991-92	1992-93	1993-94
Salary	10,545.4	10,541.3	11,003.8	11,351.4
Operating	2,499.0	2,405.0	2,380.0	2,380.0
Capital	1,637.5	1,676.0	1,635.5	1,743.5
Contract	2,207.9	2,765.0	1,782.0	1,649.0
Total	**16,889.8**	**17,387.3**	**16,801.3**	**17,123.9**

Person-year Resources

	1990-91	1991-92	1992-93	1993-94
Person-years	177	173	172	169

Table 10.7
Mineral Sciences Laboratories' Research Distribution by Program

Person-year Resources

	1990-91	1991-92	1992-93	1993-94
Environment	17	24	30	30
Recycling	16	20	25	25
Strategic Technologies	34	32	30	30
Resource Utilization	78	64	55	52
Administration and Support	28	27	25	25
Business Development	4	6	7	7
Total	**177**	**173**	**172**	**169**

Performance Monitoring

In addition to the above list of program areas and deliverables, MSL's objectives can be evaluated by the following key performance indicators.

Table 10.8
Key Performance Indicators of the Mineral Sciences Laboratories

	planned 1989-90	actual 1989-90	1990-91	1991-92	1992-93	1993-94
Cost-recovery Revenues ($000)	1,142.0	947.0	1,632.0	2,090.0	2,625.0	3,100.0
Leverage of Client Funds ($000)	2,125.0	1,441.0	2,500.0	3,150.0	3,700.0	5,000.0
Industry Share of Contracts (%)	34.0	40.0	34.4	37.5	37.5	37.5
Secondments (Person-years)						
to MSL	2.0	3.3	3.0	3.0	3.0	4.0
from MSL	2.0	1.0	3.0	4.0	4.0	4.0
Technology Transfer Seminars (non-CANMET person-days)	n/a	2,933.0	400.0	500.0	600.0	600.0

Mineral Technology Branch

Mining Research Laboratories

Mission

The Mining Research Laboratories (MRL) Division conducts research, and undertakes technology development in all areas of mining except coal and oil sands.

In support of this mandate, MRL strives to:

- identify key technological issues and challenges facing the mining industry;
- promote and plan R&D programs and projects to develop the knowledge and new technologies required by the industry;
- develop the technologies required by the industry; and
- transfer technology to the industry.

MRL also has a mandate to:

- advise on and test explosives for the Chief Inspector of Explosives under the *Canada Explosives Act*;
- test and certify equipment, supplies and materials used in gassy mines, on behalf of provincial and territorial inspectors and relevant federal agencies;
- test, calibrate and certify equipment for monitoring airborne radiation in mines, on behalf of the Atomic Energy Control Board; and
- test and calibrate radiation monitoring devices for Health and Welfare Canada.

Objectives

MRL's specific objectives are to:

1. develop technology to enhance mine productivity;
2. develop technology to enhance and promote workplace health and safety;
3. promote environmental protection and improve the quality of the environment; and
4. produce technical reports supporting mineral industry policy developments and implementations.

Structure of the R&D Program

MRL's R&D program is conducted under the EMR, Mineral and Energy Technology Sector (METS) Activity, and is divided into:

- two Sub-Activities (SA);
- eight Sub-Sub-Activities (SSA);
- 42 field projects; and
- 146 individual, ongoing technical project elements.

Although the number of SAs, SSAs and field projects remain static throughout any one year, the number of project elements is subject to change to meet demands. On September 1, 1990, there were 146.

Each project element is qualified in two ways, although most elements are multifaceted and have aspects of more than one type or category of R&D.

1. **Type of R&D:** Strategic (S); Incremental (I); Mandated (M); and Exploration (E).
2. **Mandated Category of R&D**: Policy (Po); Protection (Pt); and Productivity (Pr).

Table 10.9 shows the percentage split of the type and category of R&D for the project element technology fields.

Table 10.9
Mineral and Energy Technology Sector Activities

SUB-ACTIVITY	NUMBER OF	
Sub-Sub-Activity	Projects	Elements
Administration of the *Canada Explosives Act*		
Explosives Testing and Research	8	27
Mining		
Mining Methods and Equipment	6	25
Rock Mechanics	11	31
Mine Environment	3	18
Mineral Reserves Assessment	1	2
Mining Health and Safety	4	22
Equipment Safety and Certification	4	4
Mineral Development Agreements (MDAs)	5	17
Total	**42**	**146**

In Table 10.10 the MDA elements have been allocated to the specific technology fields.

The Priority Memorandum (from the Assistant Deputy Minister, June 19, 1990) indicated that a reasonable ratio of effort for 1991-92 onwards would be: policy- 15 percent; protection- 40 percent; and productivity- 45 percent. MRL's effort distribution already approximates these levels due to the involvement of the Canadian Explosives Atmosphere Laboratory (CEAL), the Canadian Explosives Research Laboratory (CERL), the Canadian Mining Technology Laboratory (CMTL) and the

Table 10.10
Activities by Mandated Category and Type of R&D

Figures represent % allocation of elements (ELS) to qualifiers

SUB-SUB-ACTIVITY		CATEGORY		
	ELS	Policy	Protection	Productivity
Explosives Testing and Research	27	32	55	13
Mining Methods and Equipment	32	4	40	56
Rock Mechanics	39	4	47	49
Mine Environment	18	4	84	12
Mineral Reserves Assessment	3	75	—	25
Mining Health and Safety	23	1	88	11
Equip. Safety and Certification	4	38	37	25
Total	146	15	54	31

SUB-SUB-ACTIVITY		TYPE		
	Strategic	Incremental	Mandated	Exploratory
Explosives Testing and Research	7	11	75	7
Mining Methods and Equipment	10	81	6	3
Rock Mechanics	28	69	—	3
Mine Environment	17	78	5	—
Mineral Reserves Assessment	50	50	—	—
Mining Health and Safety	—	87	9	4
Equip. Safety and Certification	25	25	50	—
Total	15	63	19	3

Elliot Lake Laboratory (ELL) in mandated certification and standards testing programs, and also mandated responsibilities in the support of the Uranium Researves Appraisal Program. Traditionally, MRL has always been oriented towards protection and nearly every project element has a significant protection component; hence the higher-than-normal effort in this field. Conversely, it is for these same reasons that there is a lower percentage of effort directed towards the exploratory R&D field.

The fiscal and person-year resources are not expected to vary significantly during the period covered by this business plan, except for the establishment of the northwest Québec Laboratory, which will require a complement of 12 person-years. At this point, it is planned that each of the three Mineral Technology Branch Divisions will contribute four person-years, thus there will inevitably be some reallocation of resources within the Division to accommodate this new unit. In addition to the 146 technical projects, there are 15 elements spread over four projects within the Management and Support Sub-Sub-Activity.

Marketing Strategy

Clients and Market Niches

MRL provides services to its clientele in the areas of productivity enhancement, health and safety, and policy information. At present, 31 percent of the Division's resources is devoted to the enhancement of productivity, 54 percent to health and safety, and 15 percent towards the development of policy information. The emerging interest in the environment will probably not alter the above figures at MRL by more than a point or two, because the overall MRL program is already slanted heavily towards environmental protection, in the industrial and global sense, and mandated policy responsibilities are expected to remain static.

MRL's broad range of R&D objectives dictates that there is a diversity of clients, which include:

- the entire Canadian mining industry, consisting of some 350 mines and 600 pits and quarries, and the companies that service them;
- private sector companies that provide services to the mining industry, such as equipment and materials manufacturers and consultants;
- various federal and provincial government departments and agencies;
- regulatory organizations and agencies;
- academic and related research establishments, both national and international; and
- the explosives industry.

It is difficult to identify specific market niches dependent upon MRL technology, although MRL does have a significant foothold in many

R&D fields. These include national facilities such as the Radon/Thoron Test Facility; the Long-lived Radioactive Dust Facility; and the certification and testing capabilities in CEAL, CERL and CMTL. MRL also has well-developed expertise in such fields as rock-bursting and crown pillar technologies; rock mechanics instrumentation and numerical modelling; diesel emissions control; and mine shaft wire-rope technology.

Major Promotion and Communication Activities

The following major promotion and communication activities are used by MRL to achieve performance targets:

- factsheets and information brochures;
- developing business opportunity documents where appropriate;
- organizing workshops, seminars and conferences to promote specific technologies;
- preparing press and news releases whenever the opportunity to promote MRL or one of its technologies arises;
- organizing displays and exhibits of MRL equipment, instrumentation or printed material at as many public gatherings as possible, such as the 1990 Annual General Meeting of the Canadian Institute of Mining and Metallurgy in Ottawa;
- MRL submits technical articles and notes to all CANMET and EMR publications such as *CEOS*, *Technology Focus* and *Entre Nous*;
- MRL works closely with the Technology Marketing Division (TMD) and always enters enthusiastically into the various business, marketing and promotional programs that TMD develops (Individual staff members at MRL are given full encouragement to attend business development and marketing seminars and workshops. There is no doubt that expertise in this field is being quickly and gainfully acquired. This training and development will continue to be sought and utilized for MRL staff);
- individually, all MRL professional staff undertake business development duties by distribution of MRL technical reports and by meeting with potential clients, which is now common for most MRL staff;
- the *Rockburst Manual* will be published in 1991-92 (It will be an important promotional tool for the Rock Mechanics Section, and may even facilitate an international conference on rockbursts); and
- a series of numerical modelling workshops are being planned for 1991-92, and with the rapid development of the 3-D and Boundary Element Application Package (BEAP) software, demand for CANMET workshops is expected to remain strong until late into the business plan period.

Strategic Thrusts, Plans and Outputs

Although strategic thrusts for MRL in the immediate future will not vary greatly from the current ones, more emphasis will be placed on developing a balanced program of cost-shared, task-shared, and cost-recovery work, with the major emphasis being placed on cost recovery and the development of cost-recovery projects that will be self-sustaining and could lead to similar projects.

Work Plans and Outputs

The federal government, on behalf of CANMET, is currently negotiating with industry and the appropriate provincial agencies in Québec to establish a technical laboratory in northwest Québec. This laboratory will have access to an underground mine and will become the MRL laboratory for on-site testing and trials of mining methods, procedures, equipment, and ideas resulting from MRL's R&D program. Initially, the laboratory will house the rock fragmentation group.

The major areas of technological development for MRL during the current business plan follow.

Explosives Technology

MRL will continue to devote 14 person-years annually to this strategic area concerned primarily with research into the safe manufacture, storage, transportation and use of explosives. Commitment of resources to supporting the *Canada Explosives Act* is restricted to developing cost-recovery revenues over and above those brought in by testing and certification work. However, MRL is increasingly undertaking more specialized cost-recovery work in the fields of testing and development of explosives and explosives accessories.

MRL's direct cost-recovery revenues will climb to about $75,000 by the end of 1990-91, with the potential to climb slowly thereafter. A contribution of $10,000 will be made by the Explosives Division towards MRL's cost-recovery revenues in 1990-91.

Some of the specific deliverables will be:

- certification of more than 500 explosives annually;
- preparation of guidelines for fireworks mortars (1991);
- determination of thermal stability of AN-based explosives and propellants;
- modelling explosives properties (non-ideal case) in 1991; and
- modelling the thermal stability of AN-based explosives (1992).

Mining Methods and Equipment

This strategic area will continue to require nine person-years annually to undertake a planned, balanced program of R&D aimed at developing innovative mining methods and procedures, instrumentation, equipment and software, for use by the industry. It is expected that cost recovery will generate revenues up to $25,000 in 1991-91, with the potential to steadily increase thereafter.

Some of the major deliverables will be:

- ***Index of Mining Technology Projects***
  published annually in both official languages

- **Mine Ventilation**
  completion of a study on mine monitoring system and mine methane emissions at the Sifto Canada Inc., Goderich Mine, including the field testing of key elements of mine ventilation control systems and strategies (1992)

- **Mine Design Guidelines**
  preparation of design guidelines for small mines in a series of software programs for use on PC hardware (1991)

- **New Mining Systems**
  Many Canadian mines coming on stream will be exploiting narrow ore bodies and so research is being concentrated on the development of systems suitable for these situations.

- **Mine Planning Systems**
  integration of the newly acquired 3-D mine design graphics package, with geotechnical data and expert systems, into a series of software programs specifically aimed at identifying mining methods for narrow-veined mines (1991-95)

- **Rock Breakage and Fragmentation**
  development of expertise and comprehensive data banks on non-explosive ground breaking technology and rock fragmentation (1991-95)

- **Technical Advisory Duties**
  Technical management will continue to be provided for three major IRAP projects on the development of: a compact underground borer (a small-diameter tunnel borer); an underground shaft drilling unit; and the development of a bulk conveyor system.

Rock Mechanics

Rock mechanics is a major research field for MRL that will be supported by 27 person-years and a budget in excess of $1 million annually. Approximately 25 percent of the project elements are dedicated to cost-shared contract work, which do not generate cost-recovery revenue. Rock mechanics, however, is a diverse discipline that gives ample scope for cost-recovery activities to be developed, and revenues are expected to reach $196,000 in 1990-91, and then climb steadily in succeeding years.

Major projects in rock mechanics will be:

- **Rockburst Research**
  The five-year Rockburst Research Program is the second phase of the Rockburst Project (1985-90). The *Rockburst Manual* will be published in 1991. The new program will identify the benefits of backfill technology; establish the mechanics of fault-slip rockbursts; facilitate the development of desirable support systems for rockbursting ground; improve wave-form interpretation techniques; and develop means to reduce the vast quantities of automated data.

- **Crown Pillar Technology**
  crown pillar design guidelines (1991), and the characterization of crown pillars and the surrounding ground, using advanced seismic tomography as one technique (1992)

- **Structural Mine Planning and Design**
  development of new guidelines and procedures for the investigation of rock mechanics in small mines, and the integration of this data into mine planning and design programs (1992).

- **Numerical Modelling**
  The Division will continue development of more sophisticated, second and third generation, analytical methods and PC software to analyze mine structures. This includes the provision of analytic support for ground control studies in mines, good cost-recovery potential and continued development of viscoplastic finite element software for ground control studies in soft rock (potash) mines.

- **Technology Transfer Workshops**
  MRL numerical modelling workshops have been extremely successful during 1990 and, with the improved 3-D and Boundary Element Application Package (BEAP) programs coming on stream, the frequency of workshops will increase during 1991 and continue through 1992 into 1993.

- **Expert Systems**
  MRL will enhance expert systems software to integrate data obtained from ground control studies and the other projects undertaken in the Rock Mechanics Section. These are for use, initially, in mine planning and design programs and, ultimately, also in prediction, reaction and correction circumstances (1994).

- **General Rock Testing**
  Laboratory programs to develop new rock testing methods and procedures and to develop data for ground control

investigations will continue at Elliot Lake and Ottawa. A compendium of Canadian rock properties for use in underground mine design will be published in 1991.

- **Specialized Rock Testing**
  Specialized geotechnical rock testing programs will continue throughout the period of the business plan in support of AECL's nuclear waste management program.

- **Instrumentation**
  Development of a borehole strain monitoring system that will accurately measure mining-induced changes in stress will continue well into 1992. The present stiff strain system will be further developed, both to operate in several borehole sizes and to measure axial strain (1993). Prototype soft rock borehole strain cells are currently on field trial, and commercial units should be available for use in soft rock mines by 1993.

- **Backfill Technology**
  The Sudbury laboratory is now well-established and fully equipped, and a comprehensive program of R&D and testing projects is being put together. A major report on the effects of size distribution of fill particles on backfill behaviour will be published in 1991, and a manual on backfill practices will be forthcoming in 1993-94.

Mine Environment

MRL will continue to devote eight person-years annually to this program. One element involves cost-shared contract responsibilities. The remainder of the elements, of which the main projects are listed below, are task-shared, joint agreement activities or cost-recovery projects. With the recent completion of the National Radon/Thoron Test Facility (NRTTF), the Long-live Radioactive Dust Facility (LLRSD) and wind tunnel installations, there is considerable scope to generate cost-recovery revenue, which is expected to climb to about $80,000 in 1990-91, with the potential to increase to $120,000 in 1991-92.

The major project areas are:

- **Dust and Radiation in Mines**
  the quantitative investigation of dust and radiation levels in mining and associated processing operations

- **The NRTTF**
  The facility is now fully operational, and testing and calibration work is being undertaken on a cost-recovery basis.

- **Mine Ventilation**
  Experimental verification of mine ventilation models for use in the automation of mine ventilation systems is ongoing and will be complete in 1992.

Mineral Reserves Assessment

MRL annually devotes two person-years to this program, which supports the EMR Uranium Reserves Appraisal Program (URAG) by providing yearly updates of Canadian uranium reserves and projected mine production capabilities. The group also supports industry by undertaking ore reserve assessment projects on a cost-recovery basis. Cost-recovery revenue expectations are relatively low in this project and will probably never realize more than $5,000 in any one fiscal year.

Health and Safety in Mines

A major MRL program that will continue to utilize seven person-years annually is health and safety in mines. Cost-recovery projects are expected to realize $87,000 in 1990-91, with slight increases in subsequent years when the commercialization of diesel emission control equipment and devices begins generating revenues from licences and royalties. Explosion R&D projects will generate $20,000, and the remaining $67,000 will come from projects involving monitoring of the air quality of mine environments.

The program includes the following major projects:

- **Diesel Emissions Control**
  Commercialization of MRL's Venturi Scrubber technology will continue until it is completed (1993). Basic research equipment and technology for "dieselized mines" is being developed, and ongoing confirmatory field tests will culminate in the demonstration of a fully automated mine ventilation system in 1993.

- **Dust Explosion Technology**
  Initially undertaken to study sulphide dusts, this project has now expanded to cover all explosible dusts. The project will result in a strategy to control sulphide and other explosible dusts in mines by 1992.

- **Gas Explosion Technology**
  Studies are carried out to determine procedures for controlling explosible gases in restricted environments, such as underground mines.

- **Mine Shaft Wire Rope and Hoisting Technology**
  MRL is working with the United States Bureau of Mines, the Ontario government, and industry to develop effective and reliable non-destructive testing instrumentation for mine shaft wire-rope maintenance.

- **Air Quality Index (AQI)**
  This project is tied in with the mine ventilation and diesel work but extends into developing standards and regulatory strategies.

Equipment Safety Certification

MRL will continue to devote six person-years annually to this program. Significant cost-recovery revenues can be generated by certification and testing work, which is expected to realize $150,000 during 1990-91. There is every indication that the revenues could escalate in subsequent years, although expanded facilities and more person-years will be required for this to occur.

The major activities in this program will be:

- **Testing and Certification**
  provision of a national facility for the testing and certification of fire-resistant materials, electrical equipment and other apparatus and materials that will be used in gassy mine atmospheres

- **Standards Development**
  participation in the development and updating of relevant national and regulatory standards

- **Quality Control**
  provision of a backup service to certification and testing, whereby MRL officers undertake annual visits to manufacturers holding equipment safety certificates, to ensure that quality assurance is maintained and that certified equipment conforms to the applicable standard

Environmental Control

MRL is planning to devote about five person-years to the Mine Environment Neutral Drainage (MEND) Project, or related research over the next several years. Although task-shared and joint project participation by industry establishments far exceeds MRL's contribution, MRL will be able to generate cost-recovery revenues of about $10,000 in 1990-91, and up to $20,000 in 1991-92, if MRL input remains the same.

The total program encompasses MRL's participation in the much larger national R&D program to neutralize acid and toxic mine tailings and rehabilitate tailings areas to a status that will support local flora and fauna.

The majority of the work is being carried out as part of the MEND program. Independent but related projects, with the participation and support of Rio Algom Ltd., Denison Mines Ltd., Noranda Mines Inc.,

and other industry establishments, are increasing the workload in this program, of which the main activities are:

- **Environmental Hazard Studies**
  studies with a large on-site experimental component aimed at determining the migration pathways followed by solutions and contaminants emanating from tailings

- **Evaluation Studies**
  evaluation of the effectiveness of alternative treatment technologies to effect an improved environment

- **Wetlands Studies**
  studies to enable techniques to be developed to stabilize wetland environments

- **Software**
  development of contaminant migration models and software for field use

With the increasing interest in the global environment, the cost of decommissioning mines is fast becoming a major expense for mining companies. The savings to be made on well-planned and executed decommissioning programs are immense. MRL and MSL are discussing their respective ideas on an integrated CANMET approach. For example, a large Canadian silver mine will reportedly spend approximately $60 million decommissioning at the end of its active life, and a large Canadian uranium mining company will incur expenditures of $20-30 million on decommission.

Resources

The following tables indicate the planned financial and personnel resources that MRL has available to support the business plan. They include the establishment of the laboratory in northwest Québec.

Table 10.11
Mining Research Laboratories' Research Distribution by Program

Financial Resources ($000)

	1990-91	1991-92	1992-93	1993-94
Explosives Technology	1,174.8	1,282.1	1,225.9	1,208.9
Mining Methods & Equipment	954.0	1,041.0	995.6	981.6
Rock Mechanics	3,142.4	3,429.1	3,279.2	3,233.4
Mine Environment	582.6	635.7	607.9	599.4
Mineral Reserve Assessment	141.9	154.9	148.1	146.0
Health & Safety in Mines	696.5	760.0	726.8	716.6
Equipment Safety & Certification	580.8	633.8	606.1	597.6
Environmental Control	339.9	370.9	354.7	349.8
Administration	1,147.6	1,252.3	1,197.6	1,180.8
Northwest Québec	—	3,930.0	2,445.0	2,885.0
Total	**8,760.5**	**13,489.8**	**11,586.9**	**11,899.1**

Person-year Resources

	1990-91	1991-92	1992-93	1993-94
Explosives Technology	14	14	14	14
Mining Methods & Equipment	9	7	7	7
Rock Mechanics	27	27	27	27
Mine Environment	8	8	8	8
Mineral Reserve Assessment	2	2	0	0
Health & Safety in Mines	7	7	7	7
Equipment Safety & Certification	6	6	6	6
Environmental Control	5	4	4	4
Administration	12	11	11	11
Northwest Québec	—	8	12	12
Total	**90**	**94**	**96**	**96**

Table 10.12
Mining Research Laboratories' Resource Allocations by Category of Expenditure

Financial Resources ($000)

	1990-91	1991-92	1992-93	1993-94
Salary	5,355.5	5,721.8	6,135.4	6,442.6
Operating	1,493.0	1,698.0	1,748.0	1,758.0
Capital	1,011.5	1,782.0	1,693.0	1,798.0
Contract	900.5	4,288.0	2,010.0	1,900.0
Total	**8,760.5**	**13,489.8**	**11,586.9**	**11,899.1**

Person-year Resources

	1990-91	1991-92	1992-93	1993-94
Person-years	90	94	96	96

Table 10.13
Breakdown of the Mining Research Laboratories' Person-year Resources

	1990-91	1991-92	1992-93	1993-94
Professional Staff	51	54	56	56
Technical Support Staff	24	25	25	25
Administrative Support Staff	15	15	15	15
Total	**90**	**94**	**96**	**96**

Performance Monitoring

MRL's performance is measured in part by a set of key performance indicators, as shown in Table 10.14. The number for upcoming seminars, workshops and CANMET-sponsored conferences have been projected on the basis of one CANMET-industry seminar per year, one CANMET-sponsored conference every second year, and numerical modelling and explosives seminars or workshops taking place at least three times per year.

Table 10.14
Key Performance Indicators of the Mining Research Laboratories

	1990-91	1991-92	1992-93	1993-94
Cost-recovery ($000)	669.0	780.0	1,075.0	1,550.0
Leverage of Funds ($000)	2,000.0	2,500.0	3,000.0	3,050.0
Cost-shared Contracts[a] ($000)	1,313.0	2,125.0	2,036.0	1,911.0
Secondments (Person-years)				
to MRL	1	3	3	4
from MRL	2	2	2	3
Industry's Share of Cost-shared Work (%)	34.4	37.5	37.5	37.5
Seminars, Workshops, etc.	4	4	5	4

a This includes the establishment of the northwest Québec Laboratory.

11 POLICY, PLANNING AND SERVICES BRANCH

Policy, Planning and Services Branch

Mission

The Policy, Planning and Services Branch (PPSB) is a client-oriented branch that accomplishes several specific missions through its divisions.

Administrative Services Division (ASD)
The ASD supports and enhances the activities of the Mineral and Energy Technology Sector (METS) in the areas of occupational health and safety, environmental protection, security, information management, facilities planning and management, materiel management and general administration.

Engineering and Technical Services Division (ETSD)
The ETSD supports CANMET R&D functions with efficient engineering, technical, operational and consultation services for design and development, construction, manufacturing and installation, and repair and maintenance.

Explosives Division (ED)
This Division administers the *Canada Explosives Act* and associated regulations.

Library and Documentation Services Division (LDSD)
The LDSD provides a comprehensive technical information service to CANMET and promotes technology dissemination to external client groups.

Research Program Office (RPO)
It is the responsibility of the RPO to ensure the efficient and effective planning, coordination and control of CANMET's R&D programs.

Technology Marketing Division (TMD)
This Division fosters, promotes and develops technology transfer for CANMET.

Branch Organization

PPSB has three divisions serving METS and the ADM's office (about eight percent of sector person-years):

Divisions	Person-years
Research Program Office	20
Technology Marketing Division	27
Administrative Services Division	16
Director General's Office	2
Subtotal	**65**

PPSB also has two divisions serving the CANMET research community:

Divisions	Person-years
Engineering and Technical Services Division	50
Library and Documentation Services Division	19
Subtotal	**69**

And one PPSB division serves the explosives industry:

Divisions	Person-years
Explosives Division	29
Total	**163**

Policy, Planning and Services Branch

Administrative Services Division

Mission

The Administrative Services Division (ASD) is responsible for supporting and enhancing the operations of the Mineral and Energy Technology Sector by planning, coordinating, directing, and monitoring the provision of services within the Sector in the areas of occupational health and safety, environmental protection, security, information management, facilities planning and management, materiel management, and general administration. ASD also provides support services to the Policy, Planning and Services Branch, with the exception of the Engineering and Technical Services Division and the Library and Documentation Services Division.

Objectives

ASD's strives to:

1. develop and maintain a safe and healthy work environment within CANMET for the resolution and prevention of health, safety and environmental issues;
2. upgrade and maintain security within CANMET to provide adequate protection of facilities, equipment, information and employees;
3. maintain an up-to-date assets-management system to assist management in resource allocation, and maximize the utilization of equipment used in support of Sector programs;
4. maintain and monitor operational and administrative information management systems to meet the requirements of CANMET and the access to information and privacy acts;
5. ensure that facilities are adequate to provide for the efficient and effective delivery of Sector programs, and meet health, safety, environmental and security requirements; and
6. promote and provide effective and efficient administrative services and practices in support of program delivery and Sector activities.

Marketing Strategy

ASD's primary clientele includes CANMET staff, EMR service groups, and other government departments. While the Division provides assistance to management and to operating Divisions of CANMET in support of program objectives and new initiatives, it interacts frequently with departmental service Branches on matters related to health and safety, environmental protection, security, facilities management, information management, materiels management, finance and personnel.

Strategic Thrusts, Plans and Outputs

Most activities in the Administrative Services Division are ongoing. Specific issues and activities that will be addressed include the following:

- develop and implement a baseline industrial hygiene program (1991-92);

- develop and implement a Waste Hazardous Material Information System auditing program (1991-92);
- make arrangements for environmental audits of CANMET facilities, such as waste disposal and management (1991-93);
- develop and implement a contingency plan for hazardous materials, for example, spills (1991-92);
- make arrangements for security surveys of CANMET facilities (Booth Street and Bells Corners) (1991-92);
- make arrangements for threat and risk assessments of CANMET facilities (Booth Street) (1991-92);
- implement recommendations to increase security in CANMET facilities (Booth Street and Bells Corners) based on previous surveys, e.g. access control conducted by the RCMP and threat and risk assessments (1991-92);
- conduct the triennial physical count of CANMET's moveable assets (1992-93);
- conduct a review of the effectiveness of implementing the departmental file classification system in CANMET (1992-93);
- prepare a long-term facility plan to meet CANMET's current and future program requirements (1991-92); and
- investigate the benefits of implementing an automated procurement and contracting system for CANMET (1991-92).

Resources

Table 11.1
Resource Allocations of the Administrative Services Division by Category of Expenditure

Financial Resources ($000)

	1990-91	1991-92	1992-93	1993-94
Salary	951.5	973.9	1,022.6	1,073.8
Operating	2,147.0	2,647.8	2,848.5	3,044.4
Capital	52.0	20.0	20.0	20.0
Total	3,150.5	3,641.7	3,891.1	4,138.2

Person-year Resources

	1990-91	1991-92	1992-93	1993-94
Person-years	16	16	16	16

Policy, Planning and Services Branch

Engineering and Technical Services Division

Mission

The mission of the Engineering and Technical Services Division (ETSD) is to support CANMET R&D functions with efficient engineering, technical, operational and consultation services.

These services are mainly, but not exclusively, in the fields of mechanical, electrical and electronics engineering, and include: design and development, construction, manufacturing and installation, repair and maintenance.

Other services include: carpentry, providing technical supplies, maintaining the EMR vehicle fleet in the National Capital Region, and lending passenger and light-cargo vehicles to CANMET personnel.

Organizational Structure to Section Level

ETSD comprises experienced engineers, technologists and trades persons. The Division's production areas are:

Mechanical

- prototype design development;
- industrial, mechanical and plant engineering;
- manufacturing and tool making;
- inspection, repair and preventive maintenance of EMR vehicles; and
- technical drafting and graphics.

Electrical and Electronics

- servicing, maintenance and trouble-shooting;
- installation of new equipment;
- design, fabrication and technical consultations; and
- retrofit of existing equipment.

Carpentry

- cabinet-making;
- pattern-making and mockup;
- painting and finishing;
- construction carpentry; and
- minor tenant services.

The administration areas are:

Administrative Support

- general office administration;
- secretarial and clerical services for ETSD; and
- personnel and financial management and reporting.

Transport and Trades Support

- bulk material handling and transportation;
- road transportation of equipment and material; and
- general upkeep of ETSD facilities.

Stores and Procurement

- purchase and supply of stock items for CANMET divisions;
- control and upkeep of inventory;
- shipping and receiving; and
- loan of passenger and light-cargo vehicles.

Resources Control

- cost accounting, resources expenditure and production reporting; and
- ETSD Management Information Systems operation and management.

Liaison

- consultation services on laboratory and accommodation renovations and modifications;
- coordination and inspection of projects; and
- liaison with CANMET laboratories and related organizations.

Marketing Strategy

Major Clients

ETSD clients, in order of priority, are:

- CANMET's research laboratories;
- other divisions of CANMET; and
- other EMR units requiring engineering and technical services. This work is subject to full cost recovery and does not exceed four percent of the production potential of ETSD.

Major Promotions and Communications Activities

- maintaining regular contact between section heads of ETSD and the laboratories;
- preparing an annual report and distributing it to CANMET clients;
- giving seminars and slide presentations to the laboratories every two years; and
- holding meetings with divisional coordinators every six months.

Strategic Thrusts, Plans and Outputs

- stronger linkage and relationships with CANMET clients;
- more involvement with CANMET laboratories in R&D projects in their planning stages; and
- linkages with external standards-setting organizations in the electrical and mechanical engineering fields, such as the Canadian Standards Association.

Major Plans and Outputs

The major plans and outputs of ETSD in the planning period are:

- to ensure good work-planning and production control with a revised Management Information System;
- to exploit production-enhancing advanced technology, especially computer applications, in order to undertake more complex work;
- to increase the share of work that is contracted out;
- to put more emphasis on planned maintenance programs to improve equipment availability and reduce life-cycle cost; and
- to integrate health, safety and environmental reviews into the ETSD managerial system.

Resources

Table 11.2
Resource Allocations of the Engineering and Technical Services Division by Category of Expenditure

Financial Resources ($000)

		planned		
	1990-91	1991-92	1992-93	1993-94
Salary	2,973.5	3,043.5	3,195.5	3,355.5
Operating	630.0	525.0	525.0	525.0
Contracts	675.0	675.0	675.0	675.0
Capital	245.0	90.0	150.0	305.0
Total	4,523.5	4,333.5	4,545.5	4,860.5

Person-year Resources

		planned		
	1990-91	1991-92	1992-93	1993-94
Person-years	50	50	50	50

Performance Monitoring

All key performance indicators in ETSD's Management Information System are oriented towards resource expenditures and production control.

The more important objectives are to:

- reduce the average annual balance of work by 10 percent within three years, starting in 1989-90;
- limit support to other EMR sectors to 4 percent of ETSD's total workload;
- spend more than 75 percent of total hours available on production; and
- ensure that at least 95 percent of productive hours are directed at client projects.

Table 11.3
Key Performance Indicators of the Engineering and Technical Services Division

	planned 1989-90	actual 1989-90	planned 1990-91	projected 1990-91	planned 1991-94
Average Annual Balance of Work (Person-hours)	8,300	8,700	8,050	8,200	7,800
Support to Other EMR Sectors (%)	max. 4.0	1.1	max. 4.0	1.5	max. 4.0
Ratio of Productive to total Person-hours (%)	min. 75.0	77.0	min. 75.0	77.0	min. 75.0
Direct to Productive Person-hours (%)	min. 95.0	95.0	min. 95.0	95.0	min. 95.0

Policy, Planning and Services Branch

Explosives Division

Mission

The Explosives Division is responsible for administering the *Canada Explosives Act* and associated regulations.

The Explosives Division has a mandate to:

- maintain public safety in the manufacture, storage and transportation of explosives;
- authorize new products for Canadian manufacture or importation into Canada;
- provide licensing to clients for manufacturing, importing, storage, and transporting of explosives; and
- perform inspections of licensed locations to enforce regulations.

The Explosives Division consists of regional offices in Vancouver, Calgary, Ottawa, Québec City and Halifax, and a headquarters office in Ottawa.

Marketing Strategy

The Explosives Division deals with explosives manufacturers and the forestry, mining, seismic and pyrotechnics industries. It liases with federal departments such as Transport Canada and Customs, and with provincial governments, police forces and fire authorities.

Communication with Clients

The Explosives Division:

- provides literature (bulletins, publications and newsletters) on safety procedures;
- maintains regular contact with clients regarding new products as well as modifications to factory plants;
- publishes and distributes annual Branch reports containing statistical information.

Strategic Thrusts, Plans and Outputs

Advancing technology and increased use of display fireworks will continue to have a major impact on the operational effects of this Division such as:

- increased production technology of mixing to produce bulk explosives at the point of use will create more locations to inspect;
- monitoring of medium-sized fireworks displays has commenced and will be a supplement to the training of fireworks supervisors; and
- consulting services in connection with large fireworks displays (such as Canada Day, Winterlude and the Montréal International Competition) will continue.

Major Plans and Outputs

The major plans and outputs of the Explosives Division for the planning period are to:

- collaborate with the Justice Department in drafting a revised *Explosives Act* for possible presentation to Parliament in the spring of 1991;
- maintaining the present level of regulatory work, with more emphasis on factories at the expense of magazine inspections; and
- making tentative plans to increase cost recovery to half of the divisional budget (assuming steady five percent-a-year inflation), as shown in the following table.

Resources

Table 11.4
Resource Allocations of the Explosives Division by Category of Expenditure

Financial Resources ($000)

	planned			
	1990-91	1991-92	1992-93	1993-94
Salary	1,724.6	1,765.2	1853.4	1946.2
Operating	370.0	460.0	410.0	410.0
Capital	59.0	59.0	59.0	59.0
Total	**2,153.6**	**2,284.2**	**2,322.4**	**2,415.2**

Person-year Resources

	planned			
	1990-91	1991-92	1992-93	1993-94
Person-years	29	29	29	29

Cost Recovery for Explosives Division ($000)

	1990-91	1991-92	1992-93	1993-94	1994-95	1995-96
Cost Recovery	320	390	485	600	735	900

Performance Monitoring

Table 11.5
Inspection Activities of the Explosives Division

	planned 1989-90	actual 1989-90	planned 1990-91	projected 1990-91	planned 1991-94
Factories	185	257	210	210	630
Reloading	30	32	23	23	69
Magazines - ML	214	199	238	238	714
Magazines - TML	755	619	645	645	1935
Magazines - Propellent	131	126	136	136	408
Magazines - Fireworks	64	95	110	110	330
Trucks - with Permits	87	119	100	100	300
Trucks - without Permits	82	89	80	80	240
Anfo Permissions	58	53	61	61	183
Two-Component Orders	2	2	2	2	6
Unlicensed Storage	88	94	103	103	309

Policy, Planning and Services Branch

Library and Documentation Services Division

Mission

The Library and Documentation Services Division's (LDSD) mission is to provide a comprehensive technical information service to CANMET research staff; and promote technology dissemination to external client groups through:

- the sharing of CANMET's technical literature collection;
- provision of computer-based, on-line access to technical information in fields related to CANMET's mission; and
- the sale of CANMET publications.

Objectives

The LDSD strives to:

1. acquire, organize and maintain library collections and services, and information retrieval expertise capable of meeting CANMET's needs for R&D information;
2. promote technology awareness and dissemination throughout the Canadian minerals and energy industries by:
   - making available, on loan, CANMET's specialized literature in mining, mineral processing, metals and energy technology;
   - cooperating with other national or international institutions to provide literature on minerals and energy technology; and
3. distribute CANMET publications in a worldwide exchange of technical information with centres of technological research whose interests are similar to those of CANMET.

Marketing Strategy

Major Clients

The principal client group of LDSD is the research staff of CANMET, consisting of about 400 scientists, engineers and technologists. LDSD also handles several thousand requests for publications or information from engineering, technical and information staff of most major companies in the mining, minerals, metals and energy industries, as well as from personnel in technology-based government departments and agencies, and from researchers in universities. A significant number of inquiries are received from members of the public.

Major Promotion and Communications Activities

To provide up-to-date technical information to its clients, LDSD engages in a variety of promotional and communications activities. The most important of these follow.

- LDSD provides a window on world-wide developments in mineral and energy technology to CANMET staff and stakeholders, through value-added processing, such as indexing and abstracting of scientific and technological literature, and through provision of computer-assisted information retrieval services.
- LDSD creates, or assists in creating, awareness of CANMET's activities by compiling, publishing and

distributing a variety of datafiles, catalogues and current-awareness bulletins describing CANMET research projects, and CANMET publications.

- As opportunities arise, LDSD participates in CANMET-sponsored seminars by preparing and mounting displays to promote CANMET publications and database products and services. Demonstrations of database search techniques are also provided where appropriate.
- LDSD enriches CANMET's own information resources, while increasing awareness of CANMET research efforts, by managing a program of information exchange with other national and international centres that are engaged in research in mineral and energy technology.

Strategic Thrusts, Plans and Outputs

General Links to Strategic Thrusts

Information is a vital ingredient of research and development. Similarly, awareness of new technologies, or new developments in the field, is equally important to maintaining efficient production, and to successfully market products produced by processing and manufacturing enterprises. Consequently, information services support the general CANMET strategic thrust by:

- providing state-of-the-art technical information to CANMET staff to assist their research and development efforts;
- cooperating with international and other national organizations to create technology information products for use by CANMET staff, as well as for diffusion to CANMET client industries, thus assisting them in improving their competitive position in the global marketplace; and
- facilitating CANMET's international technology transfer efforts through systematic inclusion of information about CANMET-sponsored research in internationally accessible computer-based datafiles.

Major Plans and Outputs

LDSD is committed to continue building and maintaining a technical literature collection that is sufficiently strong and comprehensive to meet CANMET's own information requirements. Beyond that, LDSD's acquisitions policies take into account the Division's role as the national resource collection in mineral and energy technology, and a source of specialized information to Canadian scientists and engineers. About 4,000 to 5,000 new volumes will be added to the collections during each year of the planning period.

To keep abreast of international progress in matters affecting production and utilization of mineral and energy resources, and in cooperation with national and international organizations, LDSD provides CANMET's own research staff, as well as Canadian scientists and engineers throughout the country, with on-line access to computer-based information files on mineral and energy technology.

It is expected that about 10,000 papers and documents will be analyzed, indexed, abstracted and added to five different databases during each year of the planning period. As an added benefit, this same activity helps CANMET's international technology transfer efforts by exposing CANMET-produced technologies to an international audience.

CANMET's collection of technical literature in minerals and energy technology is unequalled in Canada in scope and comprehensiveness. LDSD will continue to share this rich resource with scientists and engineers in industry and universities, and with Canadians from all walks of life, through participation in the interlibrary lending network. About 6,000 items will be lent to external clients during each year of the planning period. Loans to CANMET research staff are expected to be in the range of 100,000 to 110,000 items annually.

To bring CANMET-developed technologies to the attention of client industries, LDSD will continue to promote, sell and distribute CANMET publications. It will also supply paper copies of documents from its computer-based datafiles, and conduct computerized literature searches. About 2,500 requests per year are expected for this service.

To improve productivity and compensate for reduced personnel resources, labour-intensive but essentially repetitive functions in the library are being automated. A feasibility study (Phase I) of this multi-year project was completed in 1989. Automation of the library's cataloguing operations and remote-dial-access to the library's central catalogue (Phase II) was completed in 1990. Automation of the system to control loans to in-house staff, and to transact and monitor loans to external clients (Phase III), was completed in 1990-91.

The book purchasing sub-system and the periodicals tracking and subscription renewal module (Phase IV) will be undertaken in 1991-92. Completion is expected by December 1991, subject to availability of the software (currently under development). Fine-tuning and updating of the system, extension of on-line services to CANMET locations outside the Ottawa region, and the establishment of direct linkages with information services units of major clients is planned for 1992-93 and 1993-94.

As part of its effort to promote CANMET publications, LDSD compiles and distributes a bimonthly bulletin entitled *Open File Reports*. The bulletin describes newly released CANMET publications and provides information on how to order them. Six issues of the bulletin will be prepared during each year of the planning period.

Up to 80 percent of the services provided by LDSD are directed towards, or are performed on behalf of, CANMET's own staff, and to a lesser extent other government personnel. To keep this large group of

internal users abreast of service-related developments, and to be aware of problems that they might experience when obtaining services from the Division, a number of informational seminar presentations were made to research staff during 1989-90. The Library Advisory Committee is playing an important role as a channel of communication between the laboratories and LDSD staff. In addition, the Director met with management committees of each of the laboratory Divisions to provide information, and to receive feedback on LDSD's work.

External users are kept abreast of changes in services or of new products by periodic announcements inserted in CANMET publications. They are also given returnable postcards for them to comment on the quality and timeliness of LDSD services. All these efforts to maintain open channels of communication with client groups will continue during 1990-91 and beyond.

Since most LDSD services are provided free of charge to CANMET and other government personnel, LDSD is not a heavy contributor to cost recovery. Revenues credited to LDSD are derived primarily from the supply of paper documents from CANMET databases, requests for computerized literature searches, and handling charges for interlibrary lending services from non-governmental clients. Cost-recovery revenues in 1989-90 reached $33,000. Revenues of $40,000 are expected in 1990-91, rising to $50,000 in 1991-92, $60,000 in 1992-93 and $70,000 in 1993-94. Although the demand for these fee-based services is largely outside the control of LDSD, no effort will be spared to achieve these higher levels of revenue.

Resources

Table 11.6
Resource Allocation of the Library and Documentation Services Division by Category of Expenditure

Financial Resources ($000)	planned			
	1990-91	1991-92	1992-93	1993-94
Salary	1,129.9	1,156.5	1,214.3	1,275.1
Operating	980.0	1,032.0	1,085.0	1,138.0
Capital	115.0	100.0	100.0	120.0
Contracts[a]	270.0	283.0	297.0	312.0
Constributions[b]	50.0	60.0	60.0	60.0
Total	**2,544.9**	**2,631.5**	**2,756.3**	**2,905.1**

Person-year Resources	planned			
	1990-91	1991-92	1992-93	1993-94
Person-years	19	19	19	19

a Contract funds are administered through the RPO
b Contributions are paid directly by the Office of Energy R&D

Performance Monitoring

Table 11.7
Key Performance Indicators of the Library and Documentation Services Division

	planned 1989-90	actual 1989-90	planned 1990-91	planned 1991-92	planned 1992-93	planned 1993-94
LIBRARY SERVICES						
Addition to collections	4,700	5,125	4,500	4,800	5,000	5,000
Subscriptions to journals	2,700	2,614	2,700	2,800	2,850	2,900
Items loaned:						
to CANMET Staff	102,800	109,379	100,000	105,000	110,000	110,000
to external clients	3,500	3,661	3,700	4,000	4,200	4,500
Documents provided (on retention) to external clients	2,500	2,567	2,500	2,700	2,800	3,000
LIBRARY AUTOMATION						
Cataloguing	X	X				
Catalogue access	X	X				
Loan control (internal)			X			
Interlibrary loan control			X			
Purchasing			X	X		
Subscriptions				X		
Update (various)					X	X
DOCUMENTATION						
Additions to MINTEC	2,000	2,384	2,000	2,000	2,000	2,000
Additions to MINPROC	2,000	1,766	2,000	2,000	2,000	2,000
Additions to IEA/COAL	250	218	250	250	250	250
Additions to IEA/ENERGY	4,200	4,350	3,300	3,200	3,200	3,200
Additions to CANPUB	500	988	800	800	800	800
Cost Recovery ($000)	35	33	40	50	60	70

Policy, Planning and Services Branch

Research Program Office

Mission

The Research Program Office's (RPO) mission is to foster the efficient and effective planning, coordination and control of CANMET's R&D programs.

Objectives

RPO's broad objectives are to:

1. coordinate the preparation of the annual business plan;
2. coordinate the allocation of resources;
3. provide financial and project management information through a central data system;
4. process requisitions and invoices for contract R&D, and track funds;
5. provide secretariat services to CANMET's advisory board, the Minister's National Advisory Council to CANMET (MNACC), and its supporting committees;
6. prepare Treasury Board submissions, multi-year operational plans, main estimates, long-term capital plans, and other departmental and central agency documents;
7. coordinate project, mid-year, year-end and other reviews; and
8. liaise with CANMET's Divisions, other sectors of EMR, other agencies of the federal and provincial governments, and the private sector.

Organizational Structure

The RPO has four main units. The **Planning and Resource Allocation Section** is responsible for the annual business plan, the allocation of resources, and associated documents such as the long-term capital plan. This section also acts as the secretariat to the Business Committee of MNACC. The **Information Systems Section** maintains CANMET's central project and management information systems, and the associated computers and software, and provides support and training services to the users of the systems. The **Contracts Section** processes all CANMET's R&D contracts, and prepares monthly reports on contract budgets, commitments and expenditures. The **Program Advisors** liaise between the RPO and the operating Divisions, coordinate the preparation of R&D contracts and other documents, and provide the secretariat to MNACC's technical committees. The **Director's Office** provides overall management and support services to the Research Programs Office, and is the secretariat to MNACC itself.

Client Relations

Major Clients

RPO has two principal groups of clients. One is CANMET's Divisions, especially the line research Divisions; RPO provides these Divisions with a range of services, including financial and project management information, assistance in preparing plans and such documents as submissions to Treasury Board, and processing of R&D contracts.

The other group is CANMET as a corporate body, represented essentially by CANMET's management body (the ADM's Coordination and Business Committee) and the ADM in person. The services RPO

provides to CANMET as a corporate body include the overall business plan, preparation of submissions and presentations to central agencies and EMR's management, and recommendations on resource allocations.

RPO has other clients, including MNACC, the Office of Energy Research and Development (OERD), and those outside CANMET who want information and assistance in dealing with CANMET.

Communication with Clients

RPO's relationship with the line Divisions is defined in a Working Accord. Communications with the Divisions are frequent, through direct interaction between staff and through the electronic information systems maintained by the Research Program Office. Communication with CANMET's management is also frequent, through consultation and review of management documents such as operating plans, Treasury Board submissions and mid-year and year-end performance summaries.

Links with MNACC occur through preparation of agendas and minutes for MNACC meetings, direct contact at MNACC meetings, and correspondence with and for MNACC members. The Research Program Office also issues a quarterly newsletter for MNACC, describing recent events affecting CANMET and its clients.

Links with OERD are fostered through participation in the annual reviews of projects funded by the Panel on Energy R&D, of which OERD is the secretariat, and through ad hoc meetings as required. Links with other groups are through ad hoc meetings, correspondence and the telephone.

Strategic Thrusts, Plans and Outputs

General Links to Strategic Thrusts

Strategic thrusts of greatest concern to the Division are managerial and administrative initiatives. RPO will upgrade the Management Information System (MIS) so that CANMET's growing needs for information are met. The computer now used is at the limit of its capacity, and RPO expects to upgrade or replace it during 1991-92. The software systems in use will also be updated, with key programs rewritten in a new high-level language to increase access-speed and flexibility.

Another important initiative will be to assist MNACC to consolidate its committee structure to best meet the needs of advising the Minister. A new committee on Efficiency and Alternative Energy was established in 1990. In 1991-92 the work of this committee will be fully integrated with MNACC's six other committees.

Links with the Panel on Energy Research and Development (PERD) will be given special attention during the planning period. Nearly half of CANMET's budget now comes from PERD, and CANMET spends nearly half of PERD's total resources. This makes the relationship

between CANMET and PERD particularly important. A major objective is to ensure that CANMET fully meets PERD's reporting requirements.

RPO will play a key role in coordinating the environmental and review process (EARP) for CANMET. Demands on staff time to comply with EARP will become increasingly severe. RPO will act as a source of expertise on EARP to CANMET staff, and where possible reduce the burden on staff.

In Human Resources, RPO will work to maintain its already high level of staff morale and enthusiasm. Important elements will be career development through training and varied work assignments, and appropriate rewards for meritorious work. Accordingly, RPO will ensure that staff with potential develop the skills necessary for smooth transition through RPO's management structure.

RPO will continue to be a focus for links with other agencies, especially Treasury Board and Industry, Science and Technology. Also, RPO will strengthen its links with research planners in other government agencies, by establishing a forum at which these planners can exchange views and ideas on R&D planning.

Major Plans and Outputs

RPO's key outputs continue to be the planning and resource allocation documents, including the annual business plan, Main Estimates, and Multi-Year Operational Plans, which are prepared to a predetermined annual schedule. Other deliverables from RPO, such as Treasury Board submissions, are prepared as required.

Early in the planning period RPO will play a role in establishing a new operating regime for CANMET. This regime will be built on the descriptions already prepared with input from RPO, and take into account the results of Public Service 2000 and the recommendations of the Lortie Committee of the National Advisory Board on Science and Technology.

Key outputs include:

- the *CANMET Business Plan* (March),
- *Main Estimates* (October),
- *Multi-year Operational Plans* (MYOP) (September),
- Submissions to the Panel on Energy R&D (May),
- *Resource Allocation Tables* (preliminary in October and final in April),
- *MNACC Annual Report* (January), and
- *MNACC Minutes* (June through August, and November).

Resources

RPO's estimated resource allocations for the planning period are as follows:

Table 11.8
Estimated Resource Allocations of the Research Program Office by Category of Expenditure

Financial Resources ($000)

	1990-91	1991-92	1992-93	1993-94
Salary	1,202.1	1,287.2	1,285.8	1,350.1
Operating	407.0	407.0	407.0	407.0
Capital	162.0	219.0	102.0	102.0
Contract	99.0	92.0	92.0	92.0
Contributions	0.0	0.0	0.0	0.0
Total	**1,870.1**	**2,005.2**	**1,886.8**	**1,951.1**

Person-year Resources

	1990-91	1991-92	1992-93	1993-94
Person-years	20	21	20	20

Performance Monitoring

CANMET's key performance indicators do not apply to RPO. The nature of RPO's work is to provide a service to CANMET Divisions and their clients, to help ensure that CANMET as a whole achieves its objectives.

The best measures of RPO's performance are the timeliness and value of its outputs to its clients, for example:

- the quality and on-time production of planning and budget documents;
- the promptness of preparing R&D contracts, and processing invoices without incurring interest charges on late payments; and
- the usefulness of financial and project management information systems, including speed of response and accuracy of information.

Policy, Planning and Services Branch

Technology Marketing Division

Mission

The Technology Marketing Division's (TMD) mission is to develop, foster and promote mechanisms to facilitate technology transfer, both domestically and internationally.

TMD's mandate is to provide guidance and assistance in promoting the CANMET organization, and in achieving technology-transfer goals.

Objectives

Specific objectives include:

1. developing high-quality communications products and implementing strategies to raise the level of awareness of CANMET through publications, press releases, promotional material, conferences and seminars;
2. developing policies, procedures and guidelines on the management of CANMET's intellectual property;
3. developing standards for negotiating technology-transfer agreements with CANMET clients;
4. gathering and recording information on the mineral and energy industries, and on CANMET-client relations as they pertain to technology-transfer activities; and
5. assisting clients in accessing technologies in Canada and elsewhere.

Organization Structure

TMD is divided into five sections:

Intellectual Property Management Section - This section provides technology transfer services such as processing invention disclosures, evaluating new technologies; developing policies, procedures and guidelines for intellectual property management; providing assistance to the private sector in accessing technology and expertise in CANMET and from other public and private sources; and in accessing government funding programs, preparing and negotiating technology transfer agreements such as licences, R&D agreements, Memoranda of Understanding and consortia agreements.

Marketing Section - This section is responsible for the coordination and preparation of all promotional materials for CANMET, including the annual report, *Technology Focus* newsletter, pamphlets, brochures, and advertising. The section assists the Divisions in organizing conferences, seminars, workshops and other special events. An extensive mailing list is also managed by this section.

Editing Section - This section edits French and English text, writes articles and coordinates translation requests. It is responsible for all major technical reports and promotional material produced at CANMET.

Graphics Section - The graphics section handles text processing and the preparation of camera-ready copy and printing of both major publications and divisional reports.

Industry Relations Section - This section is responsible for establishing domestic and international networks to promote CANMET's services and products. It develops a comprehensive client-related database, including information on CANMET contacts with companies.

Clients

TMD's primary clients are CANMET's operating Divisions and their industrial partners. Researchers and managers in the laboratories have access to the full range of services provided by TMD, including advice on patenting and licensing; negotiations and preparation of agreements (cost recovery, Memoranda of Understanding, licences, multi-clients and consortia); production of technical and promotional publications; coordination of conferences and seminars; and access to government incentive programs. TMD also works with patent agents to assess the patentability of CANMET inventions.

Requests from the private sector, either through the laboratories or directly to TMD, are generally for assistance in obtaining technical and financial support for technology development or solutions to technical problems. For example, TMD has assisted more than 30 companies in obtaining funding under the National Research Council's Industrial Research Assistance Program (IRAP). In many cases, the requests for assistance come directly from companies without necessarily involving a CANMET technology. TMD, for example, will assist in identifying technologies available in the private sector, universities and other R&D organizations that may be relevant to the company's needs. TMD will help the company formulate a proposal for an IRAP application and will manage the project once approved. Operating Divisions are requested to assign a technical adviser to the project and to review proposals. TMD also maintains a standing watch on other funding programs and will provide information as appropriate.

With the dissolution of Canadian Patents and Development Limited (CPDL) TMD will provide advice to other EMR sectors relating to the protection, management and exploitation of intellectual property.

TMD also provides the chair and secretariat for the Interdepartmental Group on Intellectual Property Management, which reports to a steering committee of Assistant Deputy Ministers from science-based departments. The interdepartmental group is represented by more than 20 federal government departments and agencies, and deals with various issues pertaining to technology transfer, from a domestic and an international perspective.

Strategic Thrusts, Plans and Outputs

Links to CANMET's Strategic Thrusts

A major thrust for TMD is the need to conduct more market-oriented analyses of technologies being developed at CANMET. TMD has developed a new concept for packaging technologies, called Business Opportunity Documents (BODs) that will help in meeting this challenge. The preparation of BODs gives scientists the opportunity to assess the marketability of the technologies they are working on and the commercial application of new products and services that may follow. BODs can be prepared at any stage of technology development, from conception to commercialization. A training program for scientists on market analysis techniques will also be organized to help the process.

Other activities that will require TMD's involvement include:

- integrating CPDL's cases into CANMET's portfolio;
- providing assistance to other Sectors of EMR in the management of their intellectual property once CPDL is dissolved;
- implementing the new cost-shared contract program that encourages industrial investment in all areas of CANMET R&D;
- developing an expertise in marketing CANMET-developed software;
- implementing a three-year marketing and communications strategy to make clients more aware of the products and services that CANMET offers;
- promoting a more comprehensive domestic and international network to disseminate information on CANMET;
- developing a comprehensive client-profile database to provide CANMET researchers with up-to-date information on past and current contacts with clients; and
- taking a strong proactive approach in developing a national policy on technology transfer, through the Interdepartmental Group on Intellectual Property Management, which addresses the impediments that government labs currently face.

Work Plans and Outputs

The following is TMD's work plan and outputs for the next three years.

- the CPDL case files will be integrated into CANMET's database, and a critical review of all active cases will be completed by 1992;
- the Intellectual Property Manual, originally produced for CANMET scientists, has been in high demand in other government departments (The manual will be updated and re-issued in 1991-92);
- TMD will work with the operating Divisions to produce

business opportunity documents on CANMET technologies that will form the basis for a catalogue of technologies to be completed in 1992-93;

- TMD will evaluate 15 to 20 invention disclosures per year for patentability and commercial assessment (1991-94);
- the cost-shared contract program, approved in 1990, will be refined to encourage more industrial R&D spending on technology development, by allowing companies to retain ownership of intellectual property arising from the project (1991-94);
- a national policy on technology transfer will be developed by the Interdepartmental Group on Intellectual Property Management by 1992, to give science-based departments greater flexibility in the management of technology (CANMET provides the chair and secretariat for the Interdepartmental Group);
- a detailed three-year communications and marketing plan will be developed and implemented in consultation with EMR's Communications Department (The plan will focus on all major communications activities for the period 1991-94);
- an ad campaign that will focus on the work carried out by CANMET in support of the environment will be developed during 1991 (The ad will be targeted at client industries, the media and the public. Also related to the environment will be an information package produced during 1990-91 and updated yearly, and a video of the work CANMET does on sustainable development, to be produced in 1992);
- a pilot program will be developed in association with the Ottawa Education Foundation, for a youth education program aimed at increasing awareness of career opportunities in the R&D field, and of issues related to the environment (The pilot will be implemented in 1991);
- the private sector will be helped to access technology and expertise in CANMET, and from other public and private sources on an ongoing basis (1991-94); and
- training will be provided to CANMET scientists on marketing and intellectual property management on an ongoing basis (1991-94).

Resources

Table 11.9
Resource Allocations of the Technology Marketing Division by Category of Expenditure

Financial Resources ($000)

	1990-91	1991-92	1992-93	1993-94
Salary	1,605.7	1,643.5	1,725.6	1,812.0
Operating	843.0	784.0	784.0	784.0
Capital	59.0	50.0	50.0	50.0
Contract	200.0	200.0	200.0	200.0
Total	**2,707.7**	**2,677.5**	**2,759.6**	**2,846.0**

Person-year Resources

	1990-91	1991-92	1992-93	1993-94
Person-years	27.0	27.0	27.0	27.0

The figures shown do not include an expected $200,000 per year from EMR's Communications Department.

Performance Monitoring

TMD negotiates various types of agreements on behalf of the operating Divisions. Many of these agreements are for cost-recovery projects or for licensing technology. The following table provides projections for the number of licensing agreements and the expected revenues generated either in terms of cost recovery or royalties.

Table 11.10
Key Performance Indicators of the Technology Marketing Division

	1990-91	1991-92	1992-93	1993-94
Number of Licences	12	15	17	20
Revenues from Cost Recovery	1,215	n/a	n/a	n/a
Revenues from Royalties ($000)	40	278	290	320

The number of licences shown does not include software licences.
Revenues from cost recovery apply to agreements in which TMD was extensively involved, and include licensing provisions.